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# DIRECTOR OF SHIP MATERIAL TECHNICAL INSPECTION REPORT

AD No. **473907**

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## Radiological Decontamination of Target and Non-Target Vessels

VOLUME 2 OF 3

Classification (Cancelled) **UNCLASSIFIED**  
By Authority of *Memo. Ch. Sec. Dir.* 11/14/57  
By *Jelena* Date *3/2/62*

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OPERATION CROSSROADS  
JOINT TASK FORCE ONE

DDC

NOV 19 1965

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DIRECTOR OF SHIP MATERIAL  
TECHNICAL REPORT

⑥ OPERATION CROSSROADS.  
RADIOLOGICAL DECONTAMINATION  
OF  
TARGET AND NON-TARGET VESSELS.  
VOLUME 2.

(up  
case)

⑨ Director of Ship Material  
technical inspection rept.

⑪ 1946,

⑫ 145p.

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⑭ XRD-186

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⑩ J.J. Fee.

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This Volume 2 of 3.

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NON-TARGET VESSEL  
EXPERIMENTAL DECONTAMINATION WORK

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GENERAL REPORTS AND INFORMATION  
OF PROGRESS OF EXPERIMENTAL WORK ON REMOVAL  
OF RADIOACTIVITY AT  
SAN FRANCISCO NAVAL SHIPYARD

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REPORT NO. 1  
EXPERIMENTAL WORK, SAN FRANCISCO NAVAL SHIPYARD  
SAN FRANCISCO, CALIF.

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Report of INSPECTION FOR RADIOACTIVITY of the  
USS LAFHEY (DD724) at the San Francisco Naval Shipyard,  
5 September 1946

The USS LAFHEY DD724 was subjected to an inspection for radioactivity on 5 September 1946 at the San Francisco Naval Shipyard. The inspection, witnessed by representatives of the 12th Naval District and the Western Sea Frontier, was conducted under the supervision of Captain W. E. Walsh (MC) USN. Other members of the inspecting party were:

Dr. Robert A. Newell - a radiologist from Stanford University  
Dr. F. H. Rodenbaugh - radiologist, San Francisco  
Wayne A. Chadbourn, Lieut. (MC) USN

The necessary coordination between the Shipyard personnel and the inspecting party was maintained by Lieut. Comdr. M. E. TURNBAUGH, USN, Ass't. Repair Supt. (Hull), San Francisco Naval Shipyard.

No official conclusions were arrived at upon the completion of the inspection since samples of scale and other foreign matter still had to be subjected to laboratory analysis. Unofficial opinions of the inspecting party indicated that the USS LAFHEY was not what might be termed a "hot" ship and, hence, might be considered safe working area for Shipyard personnel with a few restrictions on the work that might be carried on. These restrictions were imposed as extra safety measures pending the outcome of laboratory reports and further study of the results of the inspection by the members of the party.

The LAFHEY was in Floating Repair Dock, ARD #32 at the beginning of the inspection. Prior to the start of pumping operations, samples of the water around the LAFHEY were tested for radioactivity

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with negative results. At the start, it had been intended to raise the vessel in increments of about three feet, monitoring the area in each increment as it was uncovered. This plan was discarded and it was decided to pump the dock dry and monitor the hull of the LAFHEY from beneath, working upward as necessary on staging.

Pumping operation commenced at 0930 and was secured at 1040. During this period, Shipyard personnel assigned to assist the inspection party were lectured to by Lt. Comdr. Turnbaugh and Lieut. Chadbourn. The basis of these lectures were explanations of what was to be done and why. This was done to eliminate any questions in the minds of the men as to the safety precautions to be carried out in order to protect themselves from radioactive particles, and, also, to assure them that no great mysterious danger faced them. Previously, each man to participate in the inspection had been equipped with canvas suits, canvas shoes, socks, underclothing, gloves and hard hats. The final instruction was a warning to be sure and prevent any small radioactive particles from entering body thru mouth, nose or open wound.

At 1130 the monitoring party descended into the dock and started a survey of the ships bottom using Geiger counters. Particular attention was paid to areas covered with marine growth or in areas of rust. The readings obtained at this point indicated that the radioactivity of the hull was considerably below the dangerous level, hence, no further measurements on the outside hull were necessary. Sample scrapings of the bottom growth were collected in buckets and monitored. The individual members of the inspection party took samples for laboratory analysis and a large supply of the scrapings were packed in cans for shipment to Navy Dept., Washington, D. C. It is to be noted here, that despite the warning by the inspection party to the Yard workers not to handle scrapings without gloves, the members of the inspection party did not observe this precaution themselves.

After the outside hull inspection was completed, the evaporator in the Forward Engine Room was opened and the First Effect tube nest was pulled out. A large piece of canvas was spread below it on the deck, and, after flushing down in order to keep dust to a minimum, the scale on the tubes was chipped off. During the actual chipping process, all personnel, except the chippers and Dr. Newell, left the Engine Room. The chippers

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were outfitted with oxygen masks for protection of the respiratory system. Dr. Newell wore a canister mask for about twenty minutes in order to have a contaminated canister for laboratory analysis.

A section of four inch salt water piping was removed from the sea suction to the evaporator distiller pump for analysis at the University of California Radiation Laboratory. Suitable blanks were provided for the pipe system from which the section was removed, and, also, the specimen itself was properly tagged to insure its return to the vessel.

The results of those tests indicated that the salt water systems were considerably more radioactive than the outside hull plating, but still not to the degree that would be unsafe for Shipyard personnel during Yard overhaul.

Following the above tests all workmen who had participated in the inspection were lined up and Geiger Counter Monitored. The results of this monitoring indicated no appreciable radioactivity, so the men were released to turn their clothes in to store for future use if necessary.

- Three items that had been used in the inspection were found to be radioactive, these were the piece of canvas, a foxtail brush and a hard bristle brush. These three items had been used for collecting samples of chipped scale from the evaporator tube nest. These three articles were encased in cement and prepared for disposal at sea, preferably in water of a depth of at least 1,000 fathoms.

As a final precaution, until the inspection board granted a definite clearance to the vessel, the hull was wet down four times a day while in dock. This was done to prevent radioactive dust particles from being blown around the Shipyard by the wind.

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SAN FRANCISCO NAVAL SHIPYARD

Code No. (200)            San Francisco 24, Calif.

DD/A3-2  
(28848)

6 SEPT 1946

To:    ComTwelve

Subj:   Telephone conversation between Captain W. E. Walsh (MC) USN,  
         Joint Task Force One, Medical Officer, and Captain C. J. Cater,  
         Planning Officer, San Francisco Naval Shipyard, 6 September  
         1946 - Confirmation of

1.      Captain Walsh informed Captain Cater that it would be satisfactory for the San Francisco Naval Shipyard to proceed with all repair and alteration work on the USS WALKE, USS BARTON, USS LAFHEY and USS LOWRY, with the exception of work on the underwater body, and any other machinery in which salt water had been circulated. Work on machinery in which salt water had been circulated will be deferred pending further notification from Captain Walsh.

2.      As regards the LAFHEY, which is now in floating drydock, care must be taken that no workmen enter the dock except those actually employed in the necessary tests. It was emphasized that no other workmen should enter the dock around the outside of the ship. It was satisfactory for the workmen to go inside the LAFHEY as set forth in paragraph 1 above.

C. J. CATER  
Captain, USN  
Planning Officer

CC: CWSF	330
District Medical Officer	163
300	100

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DISTRICT MEDICAL OFFICE  
TWELFTH NAVAL DISTRICT  
SAN FRANCISCO, CALIFORNIA

10 September 1946

CONFIDENTIAL

MEMORANDUM

To: Commander, San Francisco Naval Shipyard

Subj: Cleaning Salt Water Systems

1. The following test procedure to be used on the cleaning of non-target ships; USS LAFFEY, USS BARTON, and any other ship participating in the Bikini operations. Accurate records are to be kept of all operations and a copy forwarded by Air Mail Special Delivery to Rear Admiral T.A. Solberg, Code 180, BuShips. A copy will also be furnished to Captain W. E. Walsh, USN, District Medical Office, 50 Fell Street, San Francisco, California.

2. (a) A solution of citrate acid and ammonium hydroxide for cleaning of salt water piping systems (strength to be determined) is to be entered into the system on the out-board leg of the suction side of the suction pump. All outlets except one of the crew's water closets are to be closed. This one outlet is to allow only a minimum flow. Then at each of the other outlets of the system, water is to be drawn off until presence of the citrate acid and ammonium hydroxide solution is definitely found to be in that section of piping. Flow through the system is to be continuous to the one open outlet. The citrate acid and ammonium hydroxide solution is to be continuously entered into the system from the outboard side of the suction pumps. (over flow from the outlet may be allowed to enter the harbor). Approximate time of operation to be one hour.

(b) Second step of the cleaning operation is to completely flush out the entire system with fresh water and concentration of standard boiler compound, one (1) pound to twenty (20) gallons of water.

(c) Continuous records of the readings of the system are to be kept.

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3. (a) Samples of copper-nickel and iron piping of salt water systems are to be tested in three different concentrations of hydrochloric acid solutions of one half normal, three-quarters normal, and one normal. The pipes samples are to be tested in small sections of about three inches in length.

(b) Similar samples are to be forwarded to Dr. Scott, University of California.

(c) The object of these tests is to determine the effect of these various solutions on the cleaning marine growth, rust and other foreign matter on the inside of the pipes. Quantitative measurements of the marine growth, rust and other foreign matter on the interior of the pipe should be made before and during the testing.

4. (a) Upon the first cleaning of heat transfer units, principally evaporators, or distilling plants. On such heat transfer equipment where scale is formed by deposits from salt water systems, the scale should be cleaned as much as possible by using thermal shock treatment.

(b) All scale that has cracked off the piping shall be thoroughly removed, using standard safety precautions.

(c) A solution of muriatic acid shall then be used to further complete the removal of scale.

(d) A monitor shall be present on opening up the heat exchange unit at all times when following the above procedure.

(e) All scale removed should be segregated and dumped at sea.

5. Cleaning of the ship's side in drydock shall be accomplished in the following manner:

(a) The ship's side shall be kept moist and marine growth shall be scraped off. The growth shall be kept wet while scraping down. All materials scraped from the side of the ship shall be cleaned from the drydock and segregated. The segregated material shall be dumped at sea.

(b) Wet sandblasting, using standard equipment, is to be then used for removing the remainder of paint on the hull. The sand is also to be dumped at sea.

T. A. SOLBERG  
Rear Admiral, USN.

W. S. MAXWELL  
Captain, USN  
By direction

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**SAN FRANCISCO NAVAL SHIPYARD**  
San Francisco 24, Calif.

RECORD OF TELEPHONE CONVERSATION BETWEEN  
CAPTAIN W. G. WALSH, RADIOLOGICAL OFFICER,  
FOR JOINT TASK FORCE 1 AND CAPTAIN C. J. CATER,  
PLANNING OFFICER, SAN FRANCISCO NAVAL SHIPYARD,  
ON THIS DATE.

11 September 1946.

Captain Walsh stated that he had his apparatus ready to conduct the tests for sandblasting which he would like to conduct on 12 September starting at 9:00 A.M. Captain Cater stated the Yard would be ready.

Captain Walsh requested 1 small sandblaster be set up and that provisions be made for sandblasting a small area just the same as would be done under normal conditions. Captain Walsh assumed that the surface to be sandblasted would be wet down. In addition, the following equipment will be required.

- 3 - positive pressure masks  
3 - suits of safety clothing

(the above includes the clothing for the men operating the sandblaster and one person taking samples)

Captain Walsh requested that a vacuum blasting set be set up in a similar manner for trial following the first sandblasting mentioned above.

Captain Walsh desired to conduct a test of cutting a salt water line in a closed compartment. For this test, special clothing and pressure mask will also be required. Captain Walsh desired to try a special solution which he has developed in a contaminated saltwater line. He desires that the Yard designate a line that will hold about 50 gallons, and that may be blanked off. First, this line will be flushed out with

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Code No. (200)

fresh water and then the 50 gallons of solution will be put in and left for between 48 and 72 hours. Captain Walsh also desires the total capacity of all saltwater lines in a destroyer, and an APA.

C. J. CATER  
Captain, USN  
Planning Officer

CC: 100 165  
300 335  
330 240

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COMMANDER'S OFFICE  
SAN FRANCISCO NAVAL SHIPYARD  
SAN FRANCISCO 24, CALIFORNIA

(200)

11 September 1946

NAVAL SHIPYARD NOTICE No. 244-46

Subj: Vessels Arriving from Bikini - Instructions Governing Special Tests.

1. The following instructions will govern relative to the special tests to be conducted by the San Francisco Naval Shipyard on ships employed in the Bikini operation:

A. Planning

1. Procure funds and originate Job Orders.
2. Follow up work procedures developed, smoothing same out, and put into such form as may be promulgated to other activities.
3. Compile all data necessary for the development of such reports as may be required from time to time.

B. Production

1. Develop work procedures in accordance with existing and subsequent instructions.
2. See to it that ships have radiological clearance when they enter yard.

C. Industrial Relations

1. In consultation with Production, disseminate instructions relative to safety precautions.

J. W. FOWLER  
Commodore, USN  
Commander

DIST: CO, OH, OF, CF  
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REPORT NO. 2  
EXPERIMENTAL WORK, SAN FRANCISCO NAVAL SHIPYARD  
SAN FRANCISCO, CALIF.

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SECOND REPORT 16 September 1946 - INVESTIGATION OF RADIO-ACTIVITY of Ships from Bikini at the San Francisco Naval Shipyard starting 5 September 1946.

A First Report has been made on 6 September describing the first day of inspection for radioactivity of the USS LAFLEY DD724, drydocked in Ship Repair Dock ARD-32.

This Second Report is intended to describe chronologically subsequent events, tests, and results. At the outset it can be stated that the "Ships from Bikini" have been cleared by the monitors for all work that does not involve portions of the ship in contact with salt water. On all Bikini ships at San Francisco Naval Shipyard accordingly, all repair work has been initiated except work on the parts of the ships touched by sea water. This work, held in abeyance, will be started as soon as a monitor can be provided to work with the Shipyard in inspecting, monitoring, and issuing necessary precautions for each job. The working procedures for these jobs is dependent upon conclusions found as a result of the tests herein described.

The essential danger encountered by the presence of the radioactive ships is RADIATION POISONING of workers, which does not produce symptoms that can be detected for a long time after the initial poisoning. Radiation poisoning is effected by radioactive particles acquired in the blood, by eating, by breathing, or through an open wound.

Since even relatively minute amounts of radioactive material in the blood are likely to be harmful, it is apparent that elaborate and painstaking precautions must be taken to avoid "contamination" of workers with radioactive particles.

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Accordingly the following measures were taken by this Yard:

- (1) Detailed safety instructions for Yard men working on the hull or salt water connections of "Bikini Ships" have been issued.
- (2) Wetting down of the hull of the LAFLEY has been continued four times daily to keep dust down to a minimum.
- (3) Submarine Base, Barracks B, Bldg. 103 has been set up as a "Changing and Decontamination Center" for Yard workmen. A large room at the East end of the building has been set aside as the "Contaminated Room". Here at night Yard workmen who had been working on any Bikini Ships, completely disrobe and put all their clothing in sealed off lockers. (It would be desirable not to use this clothing again until it had been monitored for radioactivity but the fulfillment of this desire will depend on the amount of available clothing and the number of available monitors). The workers, now stripped of all clothing, walk down a strip of linoleum to the shower room where they are instructed to scrub thoroughly, especially under their finger nails. The men are told to scrub even the locker keys that they took with them from the "Contaminated Room". The workers then dry themselves off and walk on a strip of linoleum to the West end of the building where a "Clean Room" is set up. Here the worker puts on his street clothes and leaves the building, going directly from the Clean Room into the street. In the morning workers go directly into the Clean Room at the East End, remove their street clothes, leave Clean Room, and put on working clothes, either issued to them from an Issue Room in the central portion of the building or taken from lockers in the Contaminated Room. At lunch time workers are instructed to wash their hands and face thoroughly and they eat lunch at tables set up in the "Contaminated Room", all precautions being taken to avoid contact with any possible contaminated material. Workers are not permitted to reenter the Clean Room until they have had their shower at night.

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On Friday, 6 September 1946, the day after the first inspection of the LAFHEY, it was desired to remove sand and dirt on the bottom of the drydock. Lt. Comdr. Turnbaugh called Capt. Walsh for advice. Capt. Walsh advised that the dock could be washed down allowing mud to flow into the Bay. The drydock was accordingly cleared of mud. Men doing the job were properly outfitted in safety clothing although the material handled was declared free of radioactivity.

The following three working days were spent setting up safety rules and procedures and preparing for further tests.

On Thursday, 12 September 1946, a sandblasting test and a burning test on salt water piping were conducted to determine the safety of these operations. The sandblasting test started at 1100. Present were Navy Medical Officers, Capt. W. E. Walsh, and Lieut. W. A. Chadbourn, Dr. F. H. Rodenbaugh, Army First Lieutenant C. R. Calloway, all monitored in the First Report. Also present was Dr. K. G. Scott, a physiologist from the Radiation Laboratory of the University of California, and Mr. C. J. Rosati, a chemist from the Industrial Hygiene Laboratory of the Mare Island Naval Shipyard.

For the sandblasting test a sandblaster and Lieut. Calloway were lowered in a skipbox alongside the ship. The test region was shielded from the rest of the dock by two large pieces of canvas, one hung on each side of the test region and suspended from lines between the LAFHEY and the ARD. The area to be sandblasted was first wetted down and then given the usual blasting with a combination of sand and water. Lieut. Calloway had with him a fairly large instrument or machine cleaner with a filter for collecting dust particles. It bore the name "FILTER QUEEN" and was put out by the Heathmer Co. of Chicago. Several pieces of filter paper served as a filter.

During the sandblasting operation, Mr. Rosati from Mare Island set up on the main deck of the drydock, near the test region an "Electrostatic Dust Precipitator" manufactured by the Mine Safety Appliance Co. of Pittsburgh. Air was sucked in through a small metal tube in the center of which was an insulated wire. A high voltage put

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between the wire and the tube caused dust particles in the incoming air to be deposited on the tube. The metal tube was lined with a filter paper in this test so that the collected dust particles could be investigated. The filter was changed several times during the test.

At 1130 portions of the salt water piping were measured with the radiation counter and a sample piece was selected. This was unbolted from the ship, the open ends on the ship being blanked off. The sample piece was taken to the ship's shipfitter shop. A burner and Dr. Chadbourn, each wearing an oxygen mask, closed themselves in this compartment, and the sample piece of pipe was burned through, filling the compartment with smoke. The "Filter Queen" was used to collect dust samples. The operation started at 1340 and lasted 17 minutes. Adequate provision was made to rid the compartment of remaining smoke.

All filters "contaminated" during the day's tests were taken by Dr. Scott to the laboratory for analysis.

On Friday, 13 September 1946, additional supplementary tests were initiated by the Yard, although none of the medical scientists were present.

First the sandblasting test was repeated using dust collecting apparatus with a much larger airflow capacity than before. Two standard ventilation blowers with rated capacity of 1000 cubic feet per minute were set up by Shop 17, the discharge end of each being heavily packed with a glass filter 2 inches thick. One blower was placed on the skipbox with the sandblaster. With a 8 inch intake pipe this blower circulated through the filter a measured 650 cubic feet of air per minute. The other blower was put on the main deck of the drydock in the path of the main dust stream. With a 5 inch intake this blower sucked in a measured 550 cubic feet of air per minute. This test was started at 1548 and run for 40 minutes.

On Saturday, 14 September 1946, these supplementary tests were resumed, Dr. Scott and Lieut. Chadbourn being present at 0900. Dr. Scott had previously sent the Yard some acetic acid and ammonium hydroxide. The Yard provided a 50 gallon mixing container and a reciprocating air pump for mixing operations.

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A "decontaminating solution" was mixed at the Yard as follows: 25 gals. of water were placed in the mixing pot and 48 lb. of acetic acid powder was added. Ammonium hydroxide was then added until the acidity of the solution was reduced to the value pH 6.9. 34 lbs. of ammonium hydroxide was found necessary to attain this result. The solution was constantly agitated throughout the mixing operation.

The Yard opened up and blanked off a portion of the firemain having approximately 50 gal. capacity. Hose outlets were provided at each end, and the "decontaminating solution" was pumped through the blanked off section of firemain until it was entirely filled. Only about 30 gallons of solution was found required for this, indicating probably 20 gallons of sea growth in the pipe. This operation was completed at 1100 and the test scheduled to run 72 hours.

The original section of salt water piping (described in the First Report) sent to the Radiation Laboratory of the University of California was galvanized steel pipe and the solution devised was intended for steel, since it would chemically attack iron and loosen rust particles as well as dissolve marine growth. The sample of firemain selected was not steel however, it was a Copper-Nickel alloy (as is now standard for firemains) so the present test would be effective against marine growth only. Further tests on Copper-Nickel pipe are anticipated using a little sulphuric acid in the solution. Geiger Counter Readings taken at various places along the firemain were marked so that later readings will quickly determine the effect of the solution.

The burning test of Thursday was repeated by Dr. Chadbourn with a galvanized salt water pipe taken from a ship not at Bikini, the results to be used as a CONTROL.

In summary then,

The results of the tests started Thursday, 12 September 1946, have not yet been reported. It is from these results that decisions will be made on what work will be permitted on the external hulls of radioactive ships and instructions issued on how to handle the various salt water systems of these ships.

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THIRD REPORT  
16 September 1946  
INVESTIGATION OF RADIOACTIVITY  
Of Vessels from Bikini  
At the San Francisco Naval Shipyard  
Begun 5 September 1946

The principal activity today was the selection and preparation of various sections of piping aboard the USS LAFFEY and the USS HENRICO for a decontaminating experiment to be conducted tomorrow, 17 September, at 0900.

Aboard the LAFFEY in the morning Lt. Chadbourn monitored a section of the Firemain (copper nickel piping) in compartments A-208-L (Food Service) A-205-L (Crews Mess), A-204-5L and A-204-2L (Passageway). The workers from shop 56 who were to open up and blank off the Firemain had their tools monitored before going to work. Men working on a section of pipe forward of that which was to be blanked off did not wear gloves due to difficulty of access. This was done only after the Geiger reading showed the section to be very low in radioactivity. The men were instructed to wash their hands carefully afterwards. Tomorrow the section of copper nickel pipe will be pumped full of a decontaminating solution (1% hydrochloric acid). The section will stand for 72 hours after which the liquid will be drained off and tested.

On the HENRICO Lt. Chadbourn tested with the Geiger counter two sections of the Salt Water Flushing system (galvanized steel) located in the troop's head and found it sufficiently "hot" to warrant the experiment later with the two solutions (hydrochloric acid in one section, and a mixture of Citric Acid and Ammonium Hydroxide in the other.

Due to the nature of the experiments, Lt. Howell of the Industrial Laboratory has been called on to furnish assistance and required solutions.

No sandblasting has as yet been attempted. Efforts by Captain Walsh (MC) to secure a vacu-blaster has resulted in the information that the only ones available in the area are held by the 19th Fleet.

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4th Report  
18 September 1946  
INVESTIGATION OF RADIOACTIVITY  
Of Vessels from Bikini  
At the San Francisco Naval Shipyard  
Begun on 5 September 1946

Yesterday morning aboard the LAFLEY one experiment in decontaminating salt water piping was concluded and another begun. The experiment just concluded awaits laboratory testing before any results are known.

The section of Firemain which had been pumped full of pH 6.0 solution (Acetic Acid and Ammonium Hydroxide) on Saturday, 14 September at 1100, was blown out at 1100 yesterday. An air hose was attached to one end of the Firemain and a hose led from the other end to a steel barrel up on the main deck, and the Firemain was blown clear. The contents of the barrel were monitored and showed radioactive emission as heavy as had previously been found in the Firemain on Saturday (.010) which would appear to indicate that the decontaminating solution had brought a considerable portion of the radioactive particles out with it. The barrel of radioactive solution was hoisted overboard, using a quaywall crane, onto a truck and when taken to the Industrial Laboratory to be held there until arrangements are made for disposal. One quart of the solution was taken by Dr. Scott for a laboratory assay. After the Firemain had been blown clear of the solution, the air service was disconnected and a fresh water hose connected to the Firemain. The hose at the outlet end was led to a second barrel for examination of the first amount of flushing water. This water was found to be practically free of emission, so on the advice of Dr. Scott the discharge hose was led into the bay and flushing operations were scheduled to continue overnight. The flushing operation was begun at 1330. The leading man of X-56 who was holding the hose in the barrel when the radioactive solution was being blown from the firemain received spray and some of the liquid on his bare hands. He was advised to wash it off immediately.

The second shipboard experiment in decontamination of copper nickel salt water piping was begun yesterday after the necessary preparations by shop 58 had been completed. A section of approximately 50 feet had been blanked off and furnished with hose connections on each end. A reservoir in the form of a 50 gallon drum (steel barrel) was set up and filled with a 1.08% normal solution of Hydrochloric Acid. The acid was pulled from the reservoir thru a reciprocating air pump.

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to the blanked off section of Firemain (which had been flushed with fresh water for 30 minutes previously). The acid circulating operation was started at 1030. The outlet from the lower end of the Firemain was led into the reservoir drum. About 35 gallons was required to fill the main. Within a matter of minutes the drum solution began to show radioactive emission. At the end of the first hour a sample from the barrel was taken by Mr. Gordon, the yard chemist, and checked for acid content. Every two hours thereafter the solution was so checked. At 1830 the acid content had levelled off to about .45% normal and it was decided to stop this stage. At 1915 the acid circulation was stopped. Air was used to clear the Firemain of acid, all acid being led into the acid barrel. This showed considerable radioactivity. At 2050 flushing operations with fresh water were started. The first barrel of water received in flushing was too active and had to be saved for disposal at sea. The second barrel of flushing water was declared by the monitor, Dr. Chadbourn, to be safe for dumping into the bay. The discharge hose was then led overboard to the Bay. The flushing was begun at 2050, and completed at 2200, at which time air was blown thru the main. At 2210 the second acid circulating phase began. The acid was of a 0.88 concentration.

The day aboard the HENRICO was spent in blanking off the flushing system piping (galvanized steel), setting up pumps, mixing tank etc., for the third and fourth piping experiments (using pH 6.0 solution and Hydrochloric Acid solution in sections of steel piping).

In the afternoon an inspection party including Admiral Solberg, Captain Maxwell and Captain Lemler boarded the LAFHEY and was shown the work in progress. Information was given and received, and will be the subject of a separate report.

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## FIFTH REPORT.

5th Report, INVESTIGATION OF RADIOACTIVITY of Vessels from Bikini at the San Francisco Naval Shipyard begun on 5 September 1948.

Progress and further developments in the experiments described in previous reports:

Flushing (with fresh water) of the Firemain section on the LAFHEY which had been treated with pH 6. solution continued through the night of 17 September and was secured early in the morning of the 18th. The blanked off ends were opened up and drippings were collected and put in an acid barrel. Photographs were taken of the end sections of the piping, showing the work of the solution in removing marine growth. The results can be summed up by saying that the pH 6. solution was not particularly effective in removing marine growth, although it is estimated that 90% of the radioactivity was removed.

The second phase of acid circulation in the Firemain forward on the LAFHEY was stopped at 0205 Wednesday, 18 September. Flushing was begun at 0215 and at 0300 the line, containing fresh water, was secured. Samples of acid concentration were taken at intervals and a small reduction of .30 occurred. (1.08 to .79) It is estimated that the acid treatment removed 100% of marine growth and scale, and reduced radioactivity about 98%. Precise figures on the decrease in radioactivity of the acid solution between the first phase and the second phase as well as the monitoring of the piping after the decontaminating solution had been removed are contained in a report by the monitor, Dr. Chadbourn, to Capt. Walsh (MC) who is in charge of the experiments.

Yesterday afternoon short pieces of Firemain removed forward and aft of the section treated with Hydrochloric Acid and were taken up on the main deck for a future decontaminating experiment. The section taken out forward was low in radioactivity, while the section taken aft of the treated line was very high in radioactivity. Seven valves which had been found to be "hot" by the monitor were taken from various parts of the ship and made ready for immersion in a barrel of decontaminating solution (Hydrochloric Acid). The valves range from 1 inch to 4 inches IPS, and were taken from systems such as Ice Machinery Overboard Discharge, Fire and Bilge Pump discharge, Firemain, and Firemain cut-outs.

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The experiment in decontaminating galvanized steel pipe aboard the HENRICO was begun, with the mixing of the pH solution (5.95 actual) and the pumping and circulating of it in part of the Flushing system of the troop's head. Circulation was begun at 1045 and after 45 minutes of circulation, pumping was secured and the solution allowed to stand. It will be blown out 72 hours from the time of securing (1130). The circulation of Hydrochloric Acid (1 normal) was begun at 1455 through a portion of the Flushing system in the troop's head. The curve of the rate of reaction was watched from hour to hour. Circulation was stopped at some time past midnight and will be detailed in the next report.

The HENRICO asked this Yard to remove a clogged section of pipe in a troop head (2-132) and it was found that this section was extremely radioactive. The section has been removed, and a new section is being put in.

An evaporator and a condenser on the hospital ship, USS BENEVOLENCE, were monitored yesterday by Lt. Comdr. Skow (MC) with expected results. The reading through the evaporator shell was not particularly high, but scale in the evaporator (which had been cold shocked previously) was found to have a radioactive emission double the normal tolerance of human beings for gamma and beta rays. It is considered that in view of this emission rate, 8 hours of work around this type of material should be the maximum. Up to 1800 yesterday no provision had been made by the ship for taking the evaporator scale away from the evaporator room. Attention to this was called by Lt. Comdr. Skow, and provision has been made to have the scale and zincs from the condensers placed on the fantail for eventual disposition at sea. The gratings in the condenser room were found to be extremely hot radioactively in one section, and orders were given to wash the gratings and bilges with Citric Acid.

Rear Admiral Solberg, Captain Walsh, Captain Maxwell, and Captain Lemler boarded the LAFFEY and BENEVOLENCE in the afternoon and examined the results of the experiments on piping. A meeting was held aboard the BENEVOLENCE regarding various decontamination procedures which will be reported upon by Lt. Comdr. Turnbaugh, Assistant Repair Superintendent, who is representing the Yard in such matters.

Clothing issued workmen for their protection is of a heavy, winter nature and has been extremely uncomfortable for the past four days when the hottest weather of the year has prevailed. The Shop Superintendent has ordered more suitable clothing.

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San Francisco Naval Shipyard  
San Francisco 24, Calif.

File (335)

16 September 1946

MEMORANDUM

Subject: Radioactive Ships at San Francisco Naval Shipyard -  
Status to date

1. To date the following ships which took part in the Bikini operation have arrived at the San Francisco Naval Shipyard:

USS WALKE (DD723)  
USS LAFFEY (DD724)  
USS BARTON (DD722)  
USS LOWRY (DD770)  
USS O'BRIEN (DD726)  
USS HENRICO (APA45)  
USS BENEVOLENCE (AH15)

2. Partial clearance has been received from Captain W. E. Walsh (MC) USN, Radiological Officer for Joint Task Force One, for the above seven ships. By partial clearance is meant the following:

- a. All work which does not involve a surface that has been in contact with sea water may proceed normally with complete safety to all workmen and without special precautions for the men in dressing or cleaning up.
- b. Jobs which involve surfaces which are suspect by virtue of their being normally in contact with sea water can be worked only:
  - (1) When a monitor is present to inspect, and issue safety instructions for the handling of each specific job.
  - (2) When all workmen assigned to each job are properly dressed and instructed and have special facilities available for decontamination.

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To date only one job has been so opened because there has been no monitor to work with the Shipyard.

3. Captain Walsh is aware of the urgency for having a full-time monitor in the Yard. He has indicated that he will have one or two monitors available for production work beginning Tuesday, 17 September.

4. Captain Walsh with the assistance of scientists from the University of California and from Stanford has directed the following investigations and tests: (NOTE: When inspection by Geiger Counter showed Beta or Gamma emissions, samples were taken for laboratory analysis of Alpha omission.)

a. Inspection for the amount of radioactivity on the USS LAFHEY in drydocks.

(1) Inspection of barnacles, sea growth, rust, and paint on the underwater body.

(2) Inspection of the evaporators.

(3) Inspection of salt water piping.

b. Experimental sandblasting on the USS LAFHEY to determine:

(1) Amount of radioactivity in the sandblasted material in the bottom of the dock.

(2) Amount of radioactive material in the air immediately surrounding the sandblaster.

(3) Amount of radioactive matter in the dust stream floating to working areas on deck of the ship and on the side of the dock.

c. Experimental burning of a section of radioactive salt water galvanized steel pipe to determine the amount of radioactive matter in the resulting fumes.

**SECRET**

- d. Experimental sandblasting again on the USS LAFHEY, but on a much larger scale than the first experiment.
- e. Experimental "deactivation" of a section of copper nickel firemain piping on the USS LAFHEY by means of a solution of acetic acid and ammonium hydroxide - USS HENRICO.

No results of benefit to the Shipyard have been given as most samples are still under analysis.

5. The Shipyard, in Barracks "B", has facilities as a "Dressing and Decontamination Center" for 58 workmen. A working procedure has been set up for preparing a man for the job and for safeguards at the end of the shift. These facilities are being expended and include laundry service in the Yard for the government issued safety clothing which the men are required to wear.

6. Full scale work on radioactive surfaces can proceed as soon as monitors are available to the Shipyard, although the working procedure for certain jobs will depend on the results of the above experiments.

PHILIP LEMLER  
Production Officer

SECRET

File (335)

San Francisco Naval Shipyard  
San Francisco 24, Calif.

19 September 1946

MEMORANDUM TO: Commander, San Francisco Naval Shipyard,  
San Francisco.

Subject: Summary of Rear Admiral Solberg's visit to San Francisco  
Naval Shipyard on Tuesday, 17 September 1946, regarding  
experimental work on the Bikini Radioactive Ships.

1. Before arriving at San Francisco Naval Shipyard on Tuesday, 17 September 1946, Rear Admiral Solberg conferred with Captain Walsh, Radiological Officer for Joint Task Force One, and with Dr. Scott from the University of California. At this conference he was made acquainted with the laboratory results of most of the experiments so far conducted at San Francisco Naval Shipyard. After this conference he visited San Francisco Naval Shipyard to see the experimental work and to discuss with the Production Officer the work in progress. He also asked for further experimental work and inspections to be set up so as to aid on conclusions being reached as to how the shipyard should proceed with each of the problems on the radioactive ships.

2. The various items covered by Rear Admiral Solberg's visit are summarized as follows:

- (a) That the subject matter of how to rid a ship free of radioactivity should be classified as "Top Secret".
- (b) That the Bureau of Ships in setting up a "Decontamination Section" and that they are interested in and will want information concerning the experimental work being conducted here.
- (c) That he will inform the Shipyard on the following day whether or not to go ahead with the sandblasting on the USS LAFLEY. Indications at present are that it is safe.

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- (d) That the Shipyard should proceed to set up for decontaminating the evaporators on the USS BENEVOLENCE. The final order to go ahead would be given after his inspection of these evaporators the following day.
- (e) That the Shipyard have the following items ready for his inspection at 1300 on the following day:
  - (1) Circulation of decontaminating fluids in the two sections of firemain on the USS LAFHEY be concluded and these flushed sections opened up for his inspection. Also adjoining sections of firemain which had not been decontaminated should be opened as a comparison to see the effectiveness of the decontamination process in removing scale and marine growth.
  - (2) One evaporator on the USS BENEVOLENCE should be opened to check for radioactivity and to have scale samples for his inspection.
  - (3) One auxiliary condenser should be opened and a zinc obtained for his inspection.
- (f) That the Shipyard remove several salt water valves from the USS LAFHEY to test the procedure of soaking them in decontaminating chemicals in order to clear the radioactivity to the extent that the valves can be safely sent to the shop without any safety precautions in working them.

3. One item of general interest was the fact that the USS LAFHEY, which had cruised considerably in tropical waters, showed unusual heavy sea growth in her copper-nickel salt water piping. Rear Admiral Solberg stated that he was going to have this matter investigated by the Piping Section, Bureau of Ships.

/s/

PHILIP LEMLER  
Production Officer

CC: 200  
250 (for file)  
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SECRET

San Francisco Naval Shipyard  
San Francisco 24, Calif.

File (335)

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MEMORANDUM TO: Commander, San Francisco Naval Shipyard.

Subject: Summary of Rear Admiral Solberg's visit to San Francisco Naval Shipyard on Wednesday, 18 September 1946, regarding experimental work on the Bikini Radioactive Ships.

1. The first phase of Rear Admiral Solberg's visit on Wednesday, 18 September 1946, was a conference with Admiral Edwards and Commodore Fowler regarding the overall aspect of this problem of radioactive contamination of ships.

(a) The problem of the underwater body of ships and the urgency of drydocking was to be resolved as follows:

- (1) The USS LAFLEY was to be considered the example of the ship least contaminated as her hull showed little radioactivity, having been in Bikini Lagoon approximately ten days. It was noted that she had plastic paint.
- (2) The ship having commercial paint which had been in Bikini Lagoon the longest was to be considered the example of the ship with the most contamination of her underwater body. Drydocking of this ship, followed by a careful examination of her hull would yield the necessary comparison with the USS LAFLEY. From this comparison it would develop whether to drydock all Bikini ships immediately or to merely note to cognizant parties that such ships were to be handled with special precautions at their next normal docking period. Rear Admiral Solberg stated that he would check Bureau of Ships records to pick this second ship to dock.
- (3) It was pointed out by Rear Admiral Solberg that graving docks could be used for this work.

(b) The problem of contaminated salt water piping and engineering equipment was to be resolved as follows:

- (1) A burning experiment on radioactive piping was being planned. From the laboratory analysis of fume deposits from the

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experiment the danger involved in working radioactive matter could be evaluated. This experiment would represent the extreme condition. This experiment, together with those in process, would yield the needed information on the subject.

- (2) The worst conclusion would be that complete decontamination by methods now under experiment at San Francisco Naval Shipyard, or similar, would be necessary before Yard work could proceed on radioactive ships.
- (3) The optimum conclusion would be that no decontamination would be necessary before working radioactive surfaces.
- (4) Meanwhile Captain Walsh was to continue to issue "Clearance for Sailing" on the lines of present policy.

This concluded the conference.

2. Rear Admiral Solberg's party and interested Yard representatives then proceeded to inspect the experimental work. Important observations follow:

- (a) On the USS LAFHEY, the section of copper nickel piping decontaminated by the ammonium citrate standing solution showed that nearly all radioactivity had been removed. However, considerable sea growth remained.
- (b) On the USS LAFHEY, the section of copper nickel piping decontaminated by the dilute hydrochloric acid showed 98% of radioactivity removed. Also, all sea growth and scale in the pipe has been taken out.
- (c) On the USS LAFHEY, open sections of piping and valves not decontaminated were inspected and found to be of radioactive intensity below the "tolerance limit". Samples of radioactive matter were taken by Dr. Scott for further laboratory study.
- (d) The USS HENRICO was not inspected because the two steel salt water piping systems were under the process of decontamination and not ready for findings.

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- (e) The USS BENEVOLENCE evaporators were inspected. Sample scale showed more than twice the "tolerance limit". It was decided on the spot to proceed with the decontamination of the evaporators by the hydrochloric acid method.
- (f) The USS BENEVOLENCE No. 1 auxiliary condenser was examined. The zincs appeared to have concentrated the radioactive matter. The ship was instructed to replace all zincs immediately. The bilges of the generator and auxiliary condenser room showed undue radioactivity, necessitating scrubbing with a solution furnished by San Francisco Naval Shipyard.

A conference was held in the BENEVOLENCE to instruct the ship in the necessary procedures to follow in preparing for sailing.

3. Rear Admiral Solberg's party then proceeded to a conference with the Shipyard Commander and the Production and Planning Officers. Summarized items of this meeting follow:

(a) Regarding the USS LAFHEY:

- (1) For underwater body, scrape down all barnacles and save for laboratory analysis. Follow with wet sandblast. Do not dispose of sandblasted materials until investigated by monitor.
- (2) Try fresh water flushing alone as a decontaminating process on the copper nickel piping.
- (3) Remove a 15 ft. section of badly contaminated and badly fouled CuNi piping for a burning test with special control over air current in compartment. This test to be directed by Dr. Walsh or Dr. Scott. Burn in circular cuts as close together as possible. This test should have first priority.
- (4) Connect up services to USS LAFHEY.

(b) Regarding the USS BOTTINEAU:

- (1) Remove 15 ft. badly contaminated and badly fouled steel piping for burning test as described for USS LAFHEY. This test has first priority.

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(c) Regarding the USS HENRICO and USS BENEVOLENCE:

- (1) Decontaminate the entire salt water system using a flush of fresh water only. Public Works has responsibility of taking all precautions dockside to prevent contamination on Yard fresh water lines. Lieutenant Commander Turnbaugh has same responsibility on ship's side. Monitors must be given opportunity to check lines before and after process - getting inside as well as outside readings.

(d) Regarding the USS BENEVOLENCE:

- (1) The Yard is to proceed with acid decontamination of all three double effect evaporators.
- (2) The Yard will furnish information and material necessary for scrubbing down the generator room bilges.
- (3) The Yard is to procure six zincs and 200 lbs. evaporator scale and deliver to Captain Walsh for analysis. The ship will dispose of remainder of zincs and scale.

(e) Miscellaneous:

- (1) A decontamination procedure on salt water piping using steam and cold water shock followed by flushing should be tried.
- (2) Captain Walsh will furnish a summary of laboratory analysis of tests for inclusion in the Yard's record.
- (3) Suitable arrangements for bachelor quarters in the Yard or on board ship was requested for two monitors.

/s/

PHILIP LEMLER  
Production Officer

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## SIXTH REPORT

6th Report, 20 September 1946 - INVESTIGATION OF RADIO-ACTIVITY of Vessels from Bikini at the San Francisco Naval Shipyard begun on 5 September 1946.

Work was begun yesterday to implement the decisions of the medical "strategy" board convened aboard the USS BENEVOLENCE on the 18th.

In advance of one of the measures decided upon (flushing with fresh water of the Salt Water Systems of the BENEVOLENCE and HENRICO) a careful check was being made of the Salt Water Lines to insure that proper isolation of sections being worked on at present would exist, and as a corollary, to obtain a maximum flushing effect with only portions of the Salt Water system available. All Salt Water pumps were ordered inoperable (i.e. electric pumps are to be disconnected, steam driven pumps to have valves locked).

The decision to conduct a burning test on sections of hot Fire-main piping containing considerable marine growth (a top priority job) was implemented yesterday by the selection of sections of pipe from the LAFFEY and BOTTINEAU (Copper-nickel and steel respectively). Dr. Chadbourn, after monitoring the piping, selected the Shipfitters Shop aboard the LAFFEY for the test, and took samples while the burning was being done. RBA equipment was used by the burner and Dr. Chadbourn.

The senior monitor, Lt. Comdr. Skow, took readings on all three evaporators of the BENEVOLENCE in preparation for the injection of Hydrochloric Acid (1 normal) which will be started this morning. The evaporator room, because of its difficulty of access for pumps, acid barrels etc. has required considerable effort to prepare. The readings of the evaporator scale are now said to be 5 times tolerance (and hence exposure should not exceed 4-1/2 hours) not 2 times as stated in the fifth report.

BENEVOLENCE crew men who on the evening of 18 September brushed the scale from the evaporators were warned by Dr. Skow to take longer on similar jobs in the future, as due to their haste large amounts of highly active scale were deposited on piping and floor plates beneath the evaporators. Dr. Skow monitored the crew members yesterday afternoon to determine if they had acquired any radioactivity in their shoes, clothing, under fingernails etc. No activity was found.

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The pH 6. solution in the HENRICO flushing system piping will be removed Saturday morning at 1100 (72 hours after its insertion). Acid circulation on the HENRICO was stopped at 0300 the morning of the 19th. Flushing as in previous work was performed. A second phase was not planned or carried out as in the case of the LAFFEY. The monitor was unable to get any indication of radioactivity in the acid cleaned line yesterday morning, indicating the effectiveness of this method. The previous reading had been .4. In a laboratory check on the acid, the beaker became half filled with precipitate (marine growth, corrosion etc.), and it is planned to make a weight check.

The immersion of valves in Hydrochloric aboard the LAFFEY and the decontamination of sections of Firemain out on the main deck is to be accomplished as soon as resources are available.

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TAS:bd

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20 September 1946

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From: Rear Admiral T. A. Solberg, U.S.N.  
Commander Western Sea Frontier.

Subject: Report of activities in San Francisco area from Tuesday,  
17 September to Friday, 20 September.

1. I arrived in San Francisco Tuesday morning, via NATS, for the purpose of conferring on conditions existing in non-target vessels and assisting in clarifying and developing procedures necessary to establish normal operation and up-keep conditions on the subject vessels. I reported to the Commandant Twelfth Naval District and, later, to the Commander Western Sea Frontier giving such information as I had been able to collect in Washington, D. C., and outlining as far as practicable certain proposals for accomplishing the objective above.

2. A careful study has been made of the records available in the San Francisco office. Also conferences have been held with officers of the Naval Ship Yard and with Doctors Rodenbaugh and Newell of San Francisco, and Doctors Hamilton and Scott of the University of California. All aspects of the situation involving the subject vessels have been discussed at length, including also the medical and legal aspects. A number of tests are underway and certain others are proposed which will give further information in determining the best procedures in all cases.

3. A number of conclusions made and proposed decisions are submitted below. On arrival in Washington, I will take the necessary steps to present the full situation to Commander Joint Task Force One and attempt to obtain decisions in substance as shown below. The vessels involved divide themselves naturally into three categories, namely: those remaining in an operative status; those being inactivated; and those slated for disposal. The latter category of vessel presents a somewhat different problem in some respects which will be discussed with you prior to my departure Friday.

a. Docking.- Tests conducted on the U.S.S. Laffey indicate that wet sand blasting procedures on these vessels can be carried out using

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present procedures without encountering any hazards. Complete sand blasting of the Laffey will be carried out shortly and the results of the preliminary test will be verified at this time. It is believed that the procedure laid down below can be carried out under absolutely safe and practicable conditions in all navy yards and in all types of dry docks.

- (1) Remove all marine growth by careful scraping under wet conditions, preferably as the dry dock is being pumped down.
- (2) Collect from the bottom of the dock under wet conditions all of the marine growth so removed, including any found on propellers.
- (3) Dump the above material at sea.
- (4) If the ship is to be painted or touched up carry out the usual wet sand blasting procedure and collect all sand used, place in barge, and dump at sea.

NOTE: It probably would be safe, from tests made to date, to dispense from collecting sand used in sand blasting and dumping at sea. However, it is felt that the safest and soundest procedure is to carry out the dumping procedure. Attention is also invited to the fact that this procedure will be carried out only on the first docking of the subject vessels subsequent to their departure from the Marshalls area.

b. Salt Water Lines.- It would be highly desirable to decontaminate completely all salt water lines when practicable; however, it is felt that, particularly in the cases of vessels which are to remain in an operative status, that there is no immediate necessity for carrying this out. Tests to date have indicated on the ships inspected that all salt water lines can be used normally and that all normal routine repairs involving extensive cutting and welding can be carried out without encountering any hazards to workmen. However, it is considered that one minor restriction must be placed on salt water piping systems in order to be on firm ground in all respects. This restriction involves only instructing each vessel that, in case any section of salt water piping is renewed, the affected section must be sunk at sea. This will obviate any possible danger which may not have been determined.

c. Evaporators.- In some vessels at least because of the mass or volume of scale which is present, there exists also the possibility of the greatest amount of active material being present. Consequently, it is

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considered necessary that acid cleaning of all evaporating units of these vessels should be carried out once and as soon as practicable and preferably while the vessel is at sea or perhaps in an open roadstead. Acid cleaning was formerly an accepted method of cleaning but, at the present time, is restricted by the Bureau of Ships. However, I am certain that the Bureau of Ships will accede to one acid cleaning in the case of all these vessels. Acid cleaning will remove all scale in a much more thorough manner than mechanical or other type of cleaning. I personally authorized cleaning of the evaporators of the Benevolence and the Henrico because of their early departure subsequent to overhaul.

d. Boats.- Consideration of recent information and tests indicates that the decisions made with regard to disposal and sinking of small boats probably was unnecessary. It is considered that any boats which have not been disposed of as a result of these decisions should be remonitored and decisions made on the basis of information now available.

4. As stated above, I will take up the matter of clearance for these vessels as soon as I arrive in Washington and can contact all of the agencies involved. This also will include obtaining concurrence of Manhattan District. It is believed that, in case of the Benevolence and the Henrico, clearance should be given to these two vessels prior to sailing whether or not definite instructions have been promulgated from Washington. The following type of clearance in these two cases is suggested:

"U.S.S. Benevolence cleared radiologically for all operations with the following exceptions and additional instructions.

ABLE. Salt water piping can be repaired using any welding and cutting operations necessary either by ship's forces or in ship yards. BAKER. Whenever a section of salt water piping, a fitting, or valve must be renewed, the unit removed shall be retained and thrown overboard at sea. CHARLIE. At first opportunity at sea flush out all salt water lines at each outlet

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separately at high water velocity for one-half hour. DOG. Evaporators can be opened and cleaned whenever necessary. EASY. Methods of procedure involving the first docking subsequent to 25 July 1946 are being furnished to your vessel and all yards under separate letter.

5. Captain Walsh, (MC) USN, and Major Brundage, MC, USA, were present at all conferences and the subject matter above has been discussed thoroughly with them. Both concur in the recommendations contained herein.

T.A. SOLBERG

CC:  
CJTF-1  
COM12

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TAS:bd

MEMORANDUM TO: Captain Walsh

20 September 1946

Subj: Decontamination tests under way at Naval Ship Yard and University of California.

1. The following tests are either under way or will be started as soon as practicable. These tests all have as their objective obtaining information on methods of decontamination of non-target vessels in order that unrestricted clearance for both operations and repairs can be authorized to the greatest extent possible.

- a. Tests of short sections of piping which have marine growth present and show measureable activity are being made using the citrate solution, the one normal acid solution, and also plain fresh water. - The solutions are being circulated through the piping at a slow rate and readings taken periodically to determine the effects obtained. The tests involve both copper nickel and ordinary steel or wrought iron piping obtained principally from the U.S.S. LAFFEY and the U.S.S. Henrico.
- b. Tests to determine the maximum amount of cutting and welding which can be performed on both copper nickel and steel piping. - Sections of piping are being obtained from the LAFFEY and the HENRICO and being cut into small circular sections in a small enclosed space. Samples of the air in this space are being passed through a filter for subsequent analysis of the filter contents to determine whether any harmful materials are present and in what concentration.
- c. Tests of small sections of copper nickel and steel piping to determine strength of solutions necessary in order to obtain desired results. - Laboratory tests are to be made as soon as specimens can be obtained, using small samples of copper nickel and steel piping which have marine growths and measureable activity. The purpose of this is to determine the most desirable strength of solutions necessary in the case of citrate, boiler compound, and acid in order to remove marine growths expeditiously.
- d. Tests for decontamination of salt water systems. - Arrangements are being made to conduct a large scale test on decontaminating

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the salt water piping system of the USS BARTON. The chemicals to be used are dependent on the results of Paragraph (c) above, but it is proposed in the first test to use the citrate type of solution. It is planned to reduce the number of outlets in the salt water system so that the amount of circulation will be relatively small and to inject into the suction side of the salt water pump the necessary strength of solution to establish conditions found desirable from (c) above. This will require, once the test is started, opening all outlets in the salt water system in succession for a short period of time until it is evident that the entire salt water system contains the desired strength of solution. This does not involve putting the salt water system out of commission as it will be in use on a restricted basis having only those outlets absolutely necessary open. Outlets from risers should be opened periodically for short periods in order to allow a new solution to enter these risers. It is planned to remove certain valves or short sections of piping prior to and subsequent to the test in order to determine the conditions existing under both conditions.

- e. Tests of evaporators. - Use of the Bureau of Ships method of cleaning evaporators using muriatic acid is being authorized for the USS BENEVOLENCE and the USS HENRICO. The evaporator and associated units will be monitored and inspected before and after the tests to determine that the results desired have been achieved.
- f. Tests of sand subsequent to sand blasting. - Samples of sand used in sandblasting the USS LAFFEY will be obtained for critical examination in order to determine whether or not contamination is present.

2. The above tests are for the purpose of determining as soon as practicable the best possible method for complete decontamination of salt water systems in ships. Other tests underway may not make it necessary to follow decontaminating procedures on all vessels, but it is visualized that this may be required on at least some of the vessels involved.

3. Captain W. S. Maxwell and Commander Shirley will remain in the San Francisco area to assist the Naval Ship Yard and also to assist Captain Walsh in any way possible in these projects. It is also probable that Commander Hoffman will be ordered from Washington both for the purpose of assisting in this work and in order to obtain experience with the methods developed.

CC:  
Capt. Lemler, U.S. Naval  
Ship Yard, San Francisco.  
Commander Western Sea Frontier  
Commandant 12th Naval District.

T. A. SOLBERG  
Rear Admiral, USN

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FROM CONWESSEAFRON 200054Z

TO NAVY SHIP YARD SAN FRAN

UR SPEED LETTER /200-30207/ DATED 16 SEPTEMBER X ONE  
ACID CLEANING OPERATION AUTHORIZED FOR BENEVOLENCE  
AND HENRICO X USE METHOD AND MATERIALS PRESCRIBED  
IN MANUAL OF ENGINEERING INSTRUCTIONS X OBTAIN SAMPLES  
OF SCALE BEFORE CLEANING X HAVE MONITORS OBTAIN READ-  
INGS OF EVAPORATORS AND ASSOCIATED UNITS BEFORE AND  
AFTER CLEANING X DUMP SCALE REMOVED BY HAND PRIOR TO  
CLEANING AT SEA X INFORM CAPT W E WALSH MC USN OF RE-  
SULTS

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**REPORT NO. 7 - EXPERIMENTAL WORK, SAN FRANCISCO NAVAL  
SHIPYARD**

21 September 1946

Friday, 20 September 1946:

At a meeting of Ship Superintendents, Lt. Comdr. Turnbaugh outlined the experimental work yet to be done aboard the Bikini vessels. The work by ships -

**(1) USS BENEVOLENCE**

- (a) Completion of Acid experiment on Evaporators.
- (b) Flushing salt water system with fresh water.
- (c) Washing floor plates and bilges in condenser room with ammonium citrate.

**(2) USS HENRICO**

- (a) Flushing salt water system with fresh water.
- (b) Opening up, draining pH 6 line on Saturday.
- (c) Precipitating and weighing of contents found in acid used to clean flushing lines.

**(3) USS LAFLEY**

- (a) Selection, preparation, and experimentation on 10 foot suction of Cu-Ni firemain with steam-cold water shock treatment.
- (b) Selection of four sections of firemain 5 to 8 feet in length, for testing as follows:
  - 1. Solution of boiler compound, salt water, circulate through pipe.
  - 2. Solution of boiler compound, salt water, let stand in pipe.
  - 3. Solution of boiler compound, fresh water, circulate through pipe.
  - 4. Solution of boiler compound, fresh water, let stand in pipe.
- (c) Selection of firemain sufficiently long to cut into six pieces, each piece to be 4 inches long. Testing in laboratory by Dr. Scott and Mr. Gordon.

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(4) USS BOTTINEAU

(a) Same as (a), (b) and (c) on USS LAFFEY.

(5) USS BARTON

(a) Fill entire salt water system with pH6 solution except for one head to be kept usable. (Note: one other DD to be treated, tentatively USS LAFFEY.)

Work accomplished Friday, 20 September:

Four monitor, assigned to the USS BENEVOLENCE and USS HENRICO to obtain a complete set of readings of the salt water lines for each vessel (in advance of flushing the lines with fresh water) completed the vessels in the morning and afternoon respectively.

Acid circulation in the first evaporator on the USS BENEVOLENCE was begun at 0600 and continued until night when leaks in brine lines necessitated all shells be drained and the lines repaired. The second and third evaporators were flushed with fresh water in the morning. Acid circulation of the second evaporator was not accomplished due to pump failure. The third evaporator had acid circulation between 1800 on Friday to 0330 on Saturday morning.

Saturday, 21 September 1946:

Flushing of salt water lines on board the USS BENEVOLENCE and USS HENRICO was begun Saturday morning and continued through Sunday. All outlets were let run for at least one hour. Drop in pressure prevented more than four outlets being flushed at any one time. Some mains had 12 hours flushing.

It was found in opening up the evaporators of the BENEVOLENCE while awaiting completion of piping repairs that the top half contained highly active scale not touched by acid circulation, and that the inside readings on all shells averaged about 0.24 Beta. It was therefore decided to rearrange the piping and hose connections so as to institute a complete wash cycle. This included all heat exchanger units as before and especially provided for the filling of all effects completely. All fresh water and vapor lines leading from each shell had to be blanked.

Work on the USS HENRICO evaporators (two 3-effect Grisco-Russell evaporators) with acid was decided upon after consultation with the Production Officer. It was decided at the outset to make this a complete wash cycle as was found necessary on the USS BENEVOLENCE.

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A pH6 standing solution in the 50 inch test section of fire main on the USS HENRICO was opened after 72 hours (1150). The results of this test on steel piping indicated the same success in removing radioactivity as had been witnessed on the USS LAFHEY. Readings before and after will be given in a separate monitor's report.

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SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, California

23 September 1946

From: J. B. Shirley, Comdr., USN  
To : T. A. Solberg, Rear Admiral, USN  
Subj: Progress of Work at San Francisco Naval Shipyard  
Encl: (A) Copy of Memorandum from Captain Maxwell to Commander, U. S. Naval Shipyards at Puget Sound and Terminal Island.

1. Captain Maxwell went to Bremerton Naval Shipyard Sunday, 22 September 1946, and will return Tuesday, 24 September 1946.
2. Enclosure (A) was prepared in order to have in writing a confirmation of topics that would be discussed with the Commanders of the Shipyards.
3. A telephone conversation was held with Captain Maxwell today. As a result, the following recommendations are forwarded:
  - a. That another monitor be sent to the U.S. Naval Shipyard, Bremerton, Washington,
  - b. That a coordinating officer be sent to each Shipyard where work on non-target vessels will be performed and that the coordinator integrate the monitor's findings and Yard work,
  - c. That a definite policy be set up with respect to clearance of the non-target ships, and
  - d. That a set of instructions regarding the clearance of these ships and what the clearance entails be forwarded to the District Medical Officers.
4. Work on the USS BAYFIELD was started at Puget Sound.
5. The following destroyers, USS LOWRY, USS BARTON, USS WALKE AND USS O'BRIEN are to be drydocked Thursday, 26 September 1946, at Hunters Point.
6. Work on the USS BENEVOLENCE evaporator plant was delayed by finding leaky valves, drain lines completely corroded through, and unre-moved scale in the upper parts of the shell. This work is going ahead and

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should be completed by Tuesday, 24 September 1946. New Drain lines are being manufactured and the valves repaired. The valves were dipped in a twice normal solution of muriatic solution from ten (10) to thirty (30) minutes and scrubbed, followed by a rinse. This reduced reading to 0.0. Length of time in the solution appeared to be a function of Geiger readings as well as the amount of foreign matter present.

7. Work on the USS HENRICO evaporator plant is progressing satisfactorily and should be complete about Wednesday, 25 September 1946.

8. Fresh water flushing of firemain carried out on the USS BENEVOLENCE and USS HENRICO did not result in a significant change in readings even though some sections had fresh water passing through for a period of twelve (12) hours.

9. Sanblasting of the bottom of the USS LAFHEY should be completed by Wednesday, 25 September 1946.

10. Results of tests on firemain section tests:

a. USS HENRICO, galvanized steel

(1) <u>Ammonia Citrate solution pH6.0</u>	<u>Before</u>	<u>After</u>
Outside of pipe readings	.002 to .014	.000 to .003
Inside of pipe readings	.012 and over	.005 to .08
Scale was still present after test.	.5	

(2) <u>Muriatic Acid Solution 1 Normal</u>	<u>Before</u>	<u>After</u>
Outside of pipe readings	.002 to .02	.000
Inside of pipe readings	.007 & .4	.000 & .008
No scale remaining after test.		

b. USS LAFHEY, copper-nickel pipe

(1) <u>Ammonia Citrate solution pH6.0</u>	<u>Before</u>	<u>After</u>
Outside of pipe readings	.008 to .020	.000 to .007
Inside of pipe readings	.15 and over .5	.008 to .1

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(2) Muriatic Acid solution 1 Normal

	<u>Before</u>	<u>After</u>
Outside of pipe readings	.005 to 0.08	.000 to .007
Inside of pipe readings	(.08 to .2 (.3 to over .5	.000 to .002

11. Flushing of the USS BARTON firemain with an ammonia citrate solution should start Tuesday, 24 September 1946.

12. The firemain sections and valves of the USS LAFFEY have been removed and are ready to be tested, starting Tuesday, 24 September 1946 for

- a. Copper-nickel and steel with a saturated boiler compound in fresh water.
- b. Copper-nickel and steel with a saturated boiler compound in salt water.
- c. Copper-nickel and steel with a thermal shock treatment, using steam and cold water, and
- d. Copper-nickel and steel small sections in various strength muriatic acid solution.

Sections for (d) above were cut with hacksaws. The hacksaw blades had a reading of 0.0 after the work was completed, even though the sections themselves had a high Geiger reading.

13. The USS CHICKASKIA has started thermal descaling of the low pressure plant, internal readings will be taken Tuesday, 24 September 1946.

14. The Shipyard has initiated additional tests based on present findings to try to determine amount of foreign matter and material of pipes and valves removed by the acid solution.

J. B. SHIRLEY

cc: Captain Maxwell (without enclosure)  
Captain Walsh (without enclosure)  
Lt. Comdr. Turnbaugh (without enclosure)

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**REPORT NO. 8 - EXPERIMENTAL WORK AT SAN FRANCISCO  
NAVAL SHIPYARD**

Work on Monday, 23 September 1946:

USS BENEVOLENCE: Setting up of an acid mixing tank on the main deck and the hookup of the evaporators so that all six effects will be completely filled with circulating acid was accomplished during the day. The tank was set up on the main deck to simplify operations and keep the evaporator room from getting cluttered up with acid barrels, etc. Where the Yard felt it necessary, sections of piping removed from the evaporators were kept and new pipes substituted. "Hot" valves were dipped in a two normal solution of Hydrochloric Acid on the main deck. The valves showed some radioactivity after ten to twenty minutes of such treatment but were declared safe for work by X31 provided there was sufficient ventilation for anyone working on them.

The Salt Water systems of the BENEVOLENCE and HENRICO which had been flushed with fresh water Saturday and Sunday were given their final monitoring during the day. No change was observed from the previous readings, even though some lines had 12 hours of flushing. This flushing experiment was disappointing since previous observations had indicated that the scrubbing action from rapid flow water tended to dislodge foreign matter in which radioactive particles were concentrated.

USS LAFFEY and USS BOTTINEAU: Today the monitors selected the necessary lengths of piping for the tests described in the Seventh Report (a), (b) and (c). The piping lengths for (a) and (b) were assembled on the main deck of the USS LAFFEY and readied for the tests. The samples required for (c) (to go to Dr. Scott for lab assay) were cut and given to the monitors for delivery.

USS BARTON: The line leading from the sea chest to the fire and bilge pump was disconnected and a line added to the first cutout valve on the fire and bilge pump. This line, when run up to a tank on the main deck, will be used to completely fill the salt water system of the USS BARTON with a pH 6. solution.

USS HENRICO: The laboratory assay of the precipitation of foreign matter in the acid from the USS HENRICO is under way, and will be finished tomorrow.

The extensive job of preparing the evaporators of the HENRICO for an acid flushing tomorrow was pushed all day, and will be pushed with three shifts until the job is finished. This vessel, along with the BENEVOLENCE, must be out of the YARD by 0800 Thursday morning.

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25 SEPTEMBER 1946 - INVESTIGATION OF RADIOACTIVITY OF  
VESSELS FROM BIKINI, at the San  
Francisco Naval Shipyard.

Tuesday, 24 September:

Today progress was made in the decontamination of the evaporators of both the USS HENRICO and USS BENEVOLENCE. The evaporator cleaning of the BENEVOLENCE has been delayed by work on brine lines, overhaul of nine valves, and repair of a condensate cooler. Aboard the USS HENRICO acid circulation of the #2 evaporator was begun at 1500 and the #1 evaporator at 1550. A preliminary circulation of 80 gallons of acid was done the night before and scoured at 0300 when a leak in the evaporator feed line developed. Circulation continued through the night; the evaporators will be filled with soda ash and flushed today. On the BENEVOLENCE, the #1 evaporator was filled with soda ash and flushed by 1630. Readings by the monitors show that the evaporator is ready. The #2 evaporator, which had a preliminary circulation the night before, had circulation restored at about 1500, but due to pump failure after an hour of circulation and another line break at 1730, circulation through this evaporator was not up to schedule. Circulation continued all night. The #3 evaporator was drained of flushing water at approximately 1600 and circulation of acid begun.

On the USS LAFLEY, the steam-shock treatment of copper nickel and steel firemans was accomplished in the morning. The method was very effective in removing marine growth, cleaning the steel pipe completely and the copper nickel pipe almost completely, one small portion of growth still adhered. Monitor's readings (to be reported separately) indicated this system to be effective on this small length (10 ft.) section. A solution of pH 6. solution was mixed aboard the USS LAFLEY and a number of valves from the USS BOTTINEAU put in and checked at intervals through the night. The tests with boiler compound and fresh water (circulating and standing) on copper nickel and steel pipe were run. The compound was circulated for 30 minutes and no appreciable change in readings was found, which indicates the ineffectiveness of the solution. The sections which were left to stand will be opened after 24 hours for a check.

On the USS BARTON a mixing tank was set up on the Midship Deckhouse and the line which was connected to the fire and bilge pump yesterday was led up to the tank. Due to a shortage of chemists, preparation of the pH solution which is to stand in the lines was not accomplished. Due to the low readings in the salt water system of this vessel, the procedure will, if successful, demonstrate only the effectiveness of pH in removing small amounts of radioactivity in a complete salt water system. In order to get significant data it was necessary to drop 12

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valves to procure inside readings.

The USS WALKE was chosen for the second experiment of this nature, in lieu of the USS LAFLEY which has a considerable portion of her mains dismantled. Actual injection of solution is awaiting decision of the most positive solution as a result of other experiments under way.

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20 September 1946.

Wednesday, 25 September 1946:

Today saw the completion of the work on the evaporators of the USS BENEVOLENCE AND USS HENRICO. Evaporator #2 on the USS BENEVOLENCE which had acid circulation started at 1500 on 24 September was stopped at 0200 today, given a soda ash circulation and flushed. Evaporator #3 of the USS BENEVOLENCE, on which acid circulation was begun at 0100 this morning, was stopped at 1115, given soda ash circulation and flushed. On the HENRICO, acid circulation through the 2nd and 3rd effects was stopped at 0330 today and continued in the 1st effect until 0800 this morning. The #2 Evaporator (all three effects) had acid circulation until 0930 this morning. Evaporators #1 and #2 on the HENRICO were given soda ash treatment and flushed.

On the USS BARTON, pH solution was added to the firemain beginning at 2300.

Aboard the USS LAFLEY, 10 valves from the LAFLEY and BOTTINEAU were removed from their pH bath at 1600 and monitored. These valves showed maximum reduction in radioactivity in the first hour. A summary of monitor readings will be reported separately. The circulating tests with boiler compound and fresh and salt water through copper nickel and steel piping were completed and monitored. An additional test involving the circulation of boiler compound and fresh water for four hours has been decided upon and will be run tomorrow.

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SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, Calif.

26 September 1946

Rear Admiral T. A. Solberg, USN  
Code 180, Bureau of Ships  
Navy Department,  
Washington, D. C.

Dear Admiral Solberg:

Specimen Serial 1381 of 24 September was received, and all concerned here were highly pleased with its contents.

My trip to Seattle was most beneficial, as I was able to clear up many points. Upon my arrival aboard the USS BAYFIELD, I encountered trouble trying to inspect the evaporators. The evaporator room was locked and orders were issued to the effect that no one was permitted to enter. It seems that Lieutenant Shallow (monitor) issued instructions that the evaporator room was contaminated. The reason for his action was that upon arrival aboard the BAYFIELD, two tube nests were removed from the shelves and the crew had mechanically cleaned them.

It appears that the BAYFIELD was only in Bikini five days subsequent to the Baker test and was not monitored prior to her departure. The Commanding Officer was not aware of the radiological situation. After explaining the situation we were able to reassemble the evaporators and the work of circulating muriatic acid was undertaken.

All necessary personnel precautions were taken while reassembling the evaporators. I also suggested to the Captain that the men who did the mechanical scaling of the BAYFIELD evaporators be given blood counts and urinalysis tests for a period of a month and report the situation to Captain Walsh.

While in the 13th Naval District conferences were held with Commodore Thompson, Admiral Christy and Admiral Ford, who appeared to be well satisfied with my bringing them up to date on the entire situation.

I returned to San Francisco Naval Shipyard late Tuesday afternoon. Commander Shirley left this morning aboard the USS CHICKASKIA to demonstrate and explain the procedure for circulating acid through their evaporator system. He expects to return late this evening, and will leave for Pearl Sunday night.

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The USS HENRICO and USS BENEVOLENCE have been cleared and they are leaving San Francisco Naval Shipyard early this morning.

I am forwarding the progress of the experimental work at San Francisco Naval Shipyard. I might add that the interest and enthusiasm shown by the San Francisco Naval Shipyard has been most gratifying.

I will probably leave San Francisco Naval Shipyard Monday, stopping at Terminal Island Naval Shipyard enroute to Washington, and unless otherwise directed will return to Washington by the end of the month.

Respectfully yours,

W. S. MAXWELL

SECRET



27 September 1946

Thursday, 26 September 1946:

Decontamination experiments in the Yard were reduced to two with the completion of the HENRICO and the BENEVOLENCE the day before. The two remaining experiments are the circulation of boiler compound and fresh water for four hours through copper nickel and steel pipe, and the standing test of pH solution in the salt water system of the BARTON. The boiler compound solution was circulated today for four hours (from 9:30 to 1:30) through the two types of pipe which were connected together for the experiment. Monitors readings will be reported separately. Filling of the BARTON's salt water system with pH, begun the previous evening, was completed at 0400 this morning. Lines were checked to be sure there were no leaks. After 72 hours the system will be drained and monitored.

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SAN FRANCISCO NAVAL SHIPYARD  
San Francisco, 24, Calif.

Code No. (200)

CONFIDENTIAL

28 September 1946

MEMORANDUM TO: Rear Admiral T. A. Solberg, USN (Code 180,  
BuShips)

Subject: Tests Conducted in response to directives on DesDiv  
71 - USS HENRICO and USS BENEVOLENCE.

1. The enclosures present in chronological order directives and tests conducted at San Francisco Naval Shipyard on units named in the subject.
2. These data are forwarded as originally compiled and represent our preliminary draft. Due to the urgency of getting the data to you we have not held up for smoothing out. The final draft will be in a smooth form.

C. J. CATER  
Captain, USN  
Planning Officer

Encls:

- (A) General Reports and information of Progress of  
Experimental Work.
- (B) Laboratory Reports of Experimental Work.

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(335)

SAN FRANCISCO NAVAL SHIPYARD  
SAN FRANCISCO

SECRET

7 October 1946

Subj: Report of Progress on Experimental Radioactivity Decontamination Work at San Francisco Naval Shipyard:  
Period 26 September - 5 October.

Enclosures:

- (A) Monitor's Report on Decontamination of Auxiliary Condenser Injection Main of USS BENEVOLENCE - 26 September 1946.
- (B) Procedure Used in Cleaning the Salt Water System Aboard the USS BARTON.
- (C) Monitor's Report of Readings Before and After Experimental Decontamination of Salt Water System aboard the USS BARTON.
- (D) Procedure Used in Cleaning; the Salt Water System Aboard the USS WALKE.
- (E) Monitor's Report of Readings Before and After Experimental Decontamination of Salt Water System Aboard the USS WALKE.
- (F) Monitor's Report of Examination of Floating Drydock to Determine the Extent of Contamination of the Deck Floor.
- (G) Details of Valve Test in Decontaminating Chemicals.
- (H) Experimental Radiological Decontamination, USS ROCKBRIDGE - Instructions for.

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1. In the period covered by this report, the following experimental work was accomplished.

- (a) Decontamination auxiliary condenser injection lines on USS BENEVOLENCE.
- (b) Decontamination of fire and flushing system on USS BARTON.
- (c) Decontamination of fire, flushing and cooling system on USS WALKE.
- (d) Monitoring examination of floating drydock to determine extent of contamination of deck floor.
- (e) Monitor's inspection and sample sandblasting of underwater body of USS ROCKBRIDGE.
- (f) Test of valves and various solutions.
- (g) Work Progress on the USS ROCKBRIDGE.

2. Decontaminating auxiliary condenser injection lines on USS BENEVOLENCE:

The 16" crossover main between the port and starboard low injection valves showed very high external monitor readings (0.9 gamma). The distribution of the matter giving off emission was uneven, appearing to be concentrated in spots indicated on the sketch on the monitor's report (Enclosure (A)). There was insufficient time to remove a section of this injection line, so that no inspection was made on the interior. It was assumed that patches of sea growth was concentrating the radioactive water. It therefore seemed feasible (from prior experimental work) that introduction of steam followed by circulation of water would break up the sea growth and allow it to be flushed out. On each wing condenser the bonnets of the suction valves were lifted and blank flanges with pipe connections were substituted. The crossover main was first drained of all water. A steam line was run to

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the port blank and a vent line was rigged from the starboard blank. Steam was then run through the system until the temperature of the crossover main ceased to rise. (170°F.) Then valves in both the steam and bent lines were closed off and both low injection valves opened, at the same time starting the three circulating pumps. This procedure was carried on again to a pipe temperature of 195°F. before water circulation began, with no appreciable effect. The steam and vent lines were removed.

It was then decided that the only method available was to circulate muriatic acid solution through the main in order to cut the marine growth and scale loose from the pipe. A line was run from an acid mixing tank to a reciprocating air pump and hence to the pipe connection on the port blank. A recirculating line was run from the starboard blank back to the mixing tank. Inhibited muriatic acid, beginning at 2 normal concentration, was thus circulated for one hour and forty minutes. There was no time limit of circulation set beforehand. Monitors maintained constant readings of all the "hot" spots. As soon as every spot had shown changes, giving a floating reading, it was assumed that all clumps of foreign matter had been cut loose by the acid. Circulation of the acid was stopped and all acid drained from the main into barrels to be later pumped to a large container on the deck. During the circulation, the normality of the acid had dropped to 1.35 normal. Monitor readings showed only about 60% effectiveness at this stage.

Both injection valves were opened and all three circulating water pumps were started. After 15 minutes of circulation of salt water through the main, all spots showed acceptable monitor readings except one which was 0.3 gamma. Mechanical means were then resorted to in an effort to dislodge this remaining patch of foreign material. A wood block was placed on the outside of the pipe and a hammer was used for tapping. A few blows were all that were required. The reading dropped to 0.07 gamma. As of this date the low limit set for decontamination work was 0.1 gamma. Therefore, no further efforts were made. The line was drained of salt water, and then flushed with a neutralizing solution of soda ash, followed by more flushing with salt water.

The Engineering Officer of the USS BENEVOLENCE was instructed to open his auxiliary condensers one at a time to replace zincs if necessary

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and to remove sea growth that may have lodged in the heads.

3. Decontamination of the fire and flushing system on the USS BARTON.

In order to test the feasibility of decontaminating a ship's complete fire and flushing system, the USS BARTON was selected. The monitor readings of the BARTON's system showed very low activity throughout, but since the BARTON was the only ship available at the time that had its system intact, it was planned to go ahead with this test. The steps followed in conducting this experimental decontamination are detailed in Enclosure (B). The monitor's report of readings before and after the experimental work are listed in Enclosure (C).

4. Decontamination of fire, flushing and cooling system on the USS WALKE.

The USS WALKE was set up to test the procedure of decontaminating the complete fire, flushing and cooling system of a ship, using a muriatic acid solution. A complete monitoring of the USS WALKE was accomplished and all branches of the salt water system which showed no activity were excluded in the decontaminating process by closing off root valves. The major points of difference between the BARTON and WALKE experiments was the inclusion on the WALKE of the refrigeration salt water system. The procedure used in cleaning the salt water system aboard the USS WALKE is detailed in Enclosure (D), and the monitor's report of the experiment is enclosed as Enclosure (E).

5. Monitoring examination of floating drydock to determine the extent of contamination of the deck floor:

The sandblasting in dock of the USS LAFFEY was delayed because all available manpower was on urgent tank and other drydock sandblasting; therefore, a section of deck under the part of the LAFFEY's hull that had been sandblasted was cleaned up using standard drydock procedures and the areas subjected to a monitor's inspection to determine the extent that the dock remained contaminated after cleaning. A report of this inspection is enclosed, marked Enclosure (F).

6. Monitoring inspection and sample sandblasting of the underwater body of the USS ROCKBRIDGE:

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The USS ROCKBRIDGE was drydocked in Drydock No. 3 at San Francisco Naval Shipyard on 3 October. As the deck was pumped down, monitors circled the ship in a boat and took Geiger readings of the hull. From these readings they selected an area appearing to be the most active for a subsequent sandblasting test. The area selected was on the port side, Frames 40 to 60, and from the waterline down to and including the bilge keel. After pumping down, the hull was allowed to dry so as to present the worst possible condition for the sample sandblasting. This sample sandblasting was conducted on Friday, 4 October.

The sandblasters, wearing normal sandblasters' clothing and hood, and using standard wet sandblasting procedures, worked from a skipbox to accomplish the work. To windward of him in the skipbox was placed a blower having on the discharge side a 2" heavily backed glass wool filter. This blower was tested just before the sandblasting operation, and its output checked at 530 cubic feet per minute. A second blower was set up on the dock side with a suction line led down into the dock so as to be in the way of the main dust stream floating down the dock. Sandblasting of the area was carried on for a total of 36 minutes. After the operation, filters were removed and delivered to Lieutenant Commander Skow for further delivery to Dr. Scott. It was hoped in this experiment on a badly fouled hull, such as the ROCKBRIDGE had, to show if prior scraping of the barnacles or sea growth from the hull is necessary and if blasting could be safely carried on in blasting barnacles, marine growth and paint in one operation. It was also conducted to give a further check on the results obtained in the previous experimental sandblasting of the USS LAF-FEY.

7. Test of valves in various solutions:

Tests of valves to determine the amount of damage due to various solutions were conducted as an added check on observations made in using decontaminating solutions in previous experiments. These observations are summarized as follows:

- (a) Piping failures in systems in which muriatic acid and ammonium citrate have been run have been due to existing weaknesses which

failed because of the hydrostatic pressures imposed during the decontaminating procedure. These pressures have not been in excess of the prescribed hydrostatic tests on the elements which failed.

- (b) Quantitative observation of metals immersed in the decontaminating chemicals have indicated that there is very little attack by these chemicals on the metals commonly found in salt water systems.
- (c) Gasket material and packing material fails after long submergence in the decontaminating chemicals.

The results of the valve test can be summarized by saying that decontaminating solutions will not cause leaking through valves. Details of the tests are enclosed marked Enclosure (G).

8. Work on the USS ROCKBRIDGE:

This work is being very carefully planned so as to obtain the maximum of information for record and analysis. Details outlining the controls over the ROCKBRIDGE work are enclosed marked Enclosure (H). The examination of the underwater hull and the sample sandblasting are complete. Organization of the salt water piping and of the evaporator decontamination should finish 9 October and actual decontamination should start the same day.

PHILIP LEMLER  
Captain, USN  
Production Officer

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## MONITOR'S REPORT

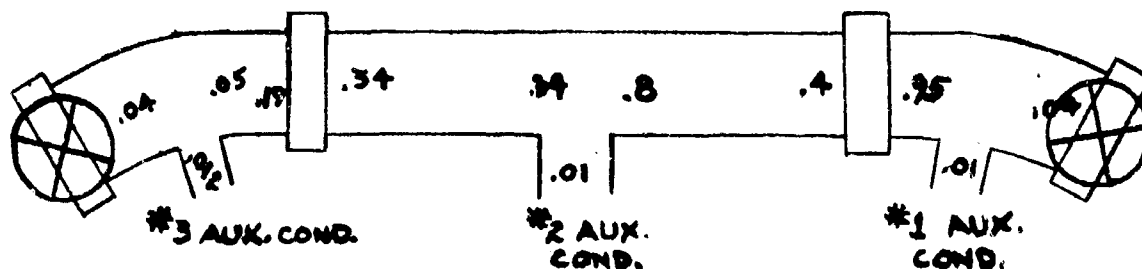
26 September 1946

### PLASTIC LINED PIPE - ACID TREATMENT

#### USS BENEVOLENCE

Clearance of Sea Suction lines in Auxiliary condenser space. Cold shock and acid.

1. Radiological condition of 16 inch sea suction line before treatment. Readings in R/24 hrs of gamma.



2. Treatment

(a) Cold shock - Steam heated to 170° followed by cold water. No change in readings.

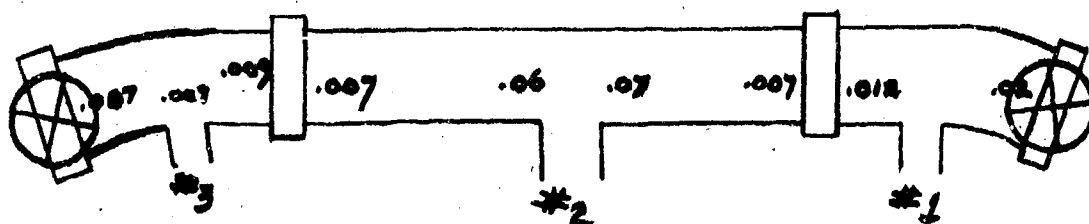
(b) Cold shock - Steam heated to 190° followed by cold water. No change in readings.

(c) 2 Normal Hcl circulated through section from inlet at #3 auxiliary condenser to outlet at #1 auxiliary condenser. Readings in acid increased to .12 R/24 hours gamma and greater than .5 R/24 hours beta and gamma. Acid was pumped out and stored in tanks. Pipe section flushed with salt water five minutes, then neutralized with soda ash and reflushed.

Encl. (A)

SECRET

3. Readings at completion of treatment as follows:



4. Summary of readings as follows: (all outside readings).

	<u>Before Treatment</u>	<u>Acid in</u>	<u>Acid removed (not flushed)</u>	<u>Flushing Completed</u>
Sea valve port	.04	.036	.036	.007
At #3 condenser	.05	.06	.06	.007
Outboard of Port expansion	.19	.29	.24	.009
Inboard of Port expansion	.34	.4	.24	.007
#2 condenser	.34	.4	.34	.06
Stb'd #2 cond.	.8	.7	.45	.07
Inboard Stb'd expansion	.4	.5	.45	.007
Outboard Stb'd expansion	.95	.6	.40	.012
Stb'd sea valve	.04	.08	.08	.02

5. From the readings with the acid in the pipes it is obvious that the activity is moved about in the pipes by the acid before it is finally removed.

During the flushing it was shown that mechanical action, such as light tapping with a carpenters mallet aided in removal of some of the activity whereas it was of no assistance in the flushing following cold shock.

Encl. (A)

SECRET

6. It is obvious that the acid removes some of the activity and loosens or prepares the remainder which is removed by flushing and neutralization.

W. A. CHADBURN  
Lt. (MC) USN

Encl. (A)

SECRET

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## MEMORANDUM

Subject: Procedure Used in Cleaning the Salt Water System Aboard the USS BARTON.

1. The following steps were used in cleaning the fire and flushing system aboard the USS BARTON.

- a. The system was completely monitored, dropping valves necessary to obtain significant readings. In spite of the prevalent low readings throughout the system it was decided to test the procedure of cleaning the entire fire and flushing system.
- b. A 500 gallon steel mixing tank was placed on the superstructure deck from which piping was run in the suction side of No. 3 fire and flushing pump in the after fire room. A riser approximately 100 feet from the fire and bilge pump was tapped to connect a recirculating line to lead back into the mixing tank.
- c. The fire and flushing systems were drained at the drain connection of the fire and flushing pumps in the two engine rooms. It was necessary to open outlets to allow air to enter the system and effect complete drainage.
- d. The double strength ammonium-citrate was mixed in the mixing tank and pumped into the fire and flushing system by No. 3 fire and flushing pump. Outlets were cracked until flow of liquid began. As each line was filled the outlet was closed. Upon complete filling of system all outlets were closed, since the ship needed no head in operation. On ships where it is necessary to provide head facilities for the crew one outlet can be let run continually. The solution was let stand in the system for periods ranging from 64 to 90 hours, legs being drained at intervals, for spot checks. At the end of 90 hours the entire system was drained from the drain connections, the drainage being collected in containers and pumped into a large tank on the deck side.

Encl. (B)

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- e. It was felt that chemical reaction on the growth inside piping would cause gaseous bubbles to form around the very material which was necessary to remove. Since circulation for the complete system from all outlets is impractical it was decided to maintain a surging pressure on the system by means of a small recirculation system so that the fire and bilge system could be continually run. This was done during the period that the ammonium-citrate was in the system. The object of this procedure was to break down or eliminate gaseous pockets.
  - f. To effect complete removal of cleaning fluid in the system air suction was taken by the fire and bilge pump and pressure put on the fire main. This purged the system by air. The system was then filled with salt water and circulated for a short period. This is not considered necessary and will not be repeated in future work of this nature. The salt water was drained out and the system again purged by air. The succeeding steps consisted of mixing a neutralizer solution of soda-ash (boiler compound) in the mixing tank and filling the system completely through No. 3 fire and bilge pump. This was allowed to stand 30 minutes and then was drained out and pumped overboard. The system again was purged by air. The final step was to take suction out of the sea chest and flush all outlets with water, each outlet being run approximately 1/2 hour. Monitor readings showed drops to practically zero in all places noted previously. These readings, are being reported separately.
2. One item of note is the fact that leakage around packing in valves and pumps developed after the ammonium citrate solution had stood 50 hours.

M. E. TURNBAUGH

Encl. (B)

SECRET

## MONITOR'S REPORT

1 October 1946

## FIREMAIN DECONTAMINATION STANDING CITRATE SOLUTION

USS BARTON

Initial readings were made on the salt water fire and flushing system of the Barton on Wednesday of last week with an X-263 meter. Early Thursday morning these same lines were pumped full of solution.

The initial set of outside readings showed such a low level of radioactivity that several valves were dropped in order to obtain readings. Comparison of "before" and "after" treatment readings shows that in only three places did significant changes occur. In view of the fact that initial outside readings were so low, no readings taken during the time the solution was in the lines were found to be significant. In the valves for which readings are shown, the solution was allowed to stand for 92 hours.

The eleven valves which were dropped were lettered A thru K from the aft end to the forward end of the ship.

All readings shown are gamma plus beta and were taken on lines from 1 to 4 inches inside diameter.

	<u>BEFORE TREATMENT</u>	<u>AFTER TREATMENT</u>
Value A	0.002	0.002
B	0.017	0.009
C	0.084	0.003
D	0.002	0.000
E	0.002	0.007
F	0.006	0.006
G	0.072	0.006
H	0.003	0.002
I	0.002	0.002
J	0.001	0.000
K	0.005	0.002

Encl. (C)

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All valves and lines inspected were found to be free of marine growth and scale, save a few places where small numbers of barnacles were found.

The rise in radioactivity at value E possibly was caused by the collection at that point of a small amount of sludge which did not drain from the line.

More information is shown below on the three valves in which significant lowering of activity occurred.

#### AFTER TREATMENT

##### VALVE B

Location : C-204LM (Crew's Sleeping Compartment)  
Size : 3" inside diameter line  
Material : Copper-Nickel  
Readings : Open ends of both pipe section on either side of valve-----0.004

Open ends of valve-----aft-----0.007  
fwd-----0.009

Nothing in line but small amount of sediment

##### VALVE C

Location : Fire main in aft engine room against aft bulkhead  
on starboard side.  
Size : 4" inside diameter line.  
Material : Copper-Nickel  
Readings : Open ends of both pipe sections---0.003  
Open ends of valve-----0.003

Piple completely free of growth and sediment.

Encl. (C)

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VALVE G

Location : A-205-L (Crew's Mess), fire main.  
Size : 4" inside diameter line.  
Material : Copper-Nickel  
Readings : Open ends of both pipe sections. -----0.004  
Open ends of valve. -----0.006

A few small barnacles, no other growth or scale.

After the solution was drained from all the lines it was discovered that the solution had not passed through valve F. This happened because a leaky valve made it necessary to close-off this section of line. A few feet lower down on the same line, next to a fire and bilge pump, another valve was removed and found to read 0.3 gamma plus beta.

J.R. H. WILSON  
Monitor

Encl. (C)

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SAN FRANCISCO NAVAL SHIPYARD  
SAN FRANCISCO 24, CALIFORNIA

SECRET

MEMORANDUM

Subject: Procedure Used in Cleaning the Salt Water System Aboard  
the USS WALKE.

1. The following steps were used in cleaning the salt water system aboard the USS WALKE.
  - a. The system was completely monitored, dropping valves necessary to obtain significant readings. The system originally had very low activity readings.
  - b. A mixing tank was placed on the superstructure deck from which piping was run into the suction side of No. 3 fire and bilge pump in the after fire room. A riser approximately 100 feet from the fire and bilge pump was tapped to connect a recirculating line to lead back into the mixing tank.
  - c. The fire flushing systems were drained at the drain connection of the fire and flushing pumps in the engine room. It was necessary to open all outlets to allow air to enter the system and effect complete drainage.
  - d. One (1) normal inhibited murlatic acid was mixed in the mixing tank and pumped into the system by the No. 3 fire and bilge pump. Outlets were cracked until flow of liquid began. As each line was filled the outlet was closed. When the entire system was filled, all outlets were closed and circulation was begun. The acid control information was as follows:

Encl. (D)

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1. Circulation was begun at 1230
2. Circulation was stopped at 1545
3. Readings of the acid were as follows:

- a. 1.1 normal at 1300
- b. 1.02 normal at 1400
- c. .95 normal at 1515
- d. .93 normal at 1545

e. It was felt that chemical reaction on the growth inside piping would cause gaseous bubbles to form around the very material which was necessary to remove. Since circulation for the complete system from all outlets is impractical it was decided to maintain a surging pressure on the system by means of a small recirculation system so that the fire and bilge pump could be continually run. This was done during the period that the acid was in the system. The object of this procedure was to break down or eliminate gaseous pockets. When samples were taken from the lines where there was no circulation. It was found that the normality of the acid was very low, (0.4 normal)

f. The acid solution was removed from the system in the following manner:

1. The recirculation hose which was discharging into the mixing tank was led into the collecting tank on the dock side. By running #3 F and B pump back suction was placed on the firemain and a portion of it cleared of acid.
2. The recirculation hose was then connected to the suction side of #3 F and B pump and the pump ran 15 strokes. This pulled acid into the suction mains of the pump. Then the recirculation hose was led to the collecting tank and the #3 F and B pump ran, this acid was discharged. This process was repeated about 20 times.
3. Then men were stationed at all plugs. Air suction was taken on the F and B pump, placing pressure on the mains. Valves on the plugs were opened, and all acid collected in buckets.

Encl. (D)

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4. The refrigeration cooling system was drained by removing the cap on the plug in the overboard discharge, and the acid collected in a container setting in the floor of the dry-dock.

g. After the system was flushed with water, it was purged with air and filled with a neutralizing solution of Soda Ash. This was circulated through the system for about thirty minutes, let stand overnight and then was pumped overboard. The system was again purged with air and flushed very vigorously and completely with water. Hoses were put on all outlets in order to complete a thorough flushing. The monitor readings for this experiment will be reported separately.

2. As far as can be determined there was no damage caused to the system.

3. A total of 26 men and 2 officers completed the above process in a total of eleven hours.

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# MONITOR'S REPORT

7 October 1946

## Fire Main Decontamination Circulated Acid Solution

### USS WALKE

In Hcl inhibited was circulated thru the fire mains of the ship on Friday, 4 October 1946. Later the acid was dumped, followed by circulation of the neutralizer and flushing.

Radiation readings were taken before the acid treatment and today.

Sections of fire main:

before	-	.014	.021	.07
after	-	.007	.007	.012

Some bonnets were removed from valves along with a section of fire main, read and photographed prior to the test. Today after the acid treatment the procedure was repeated.

Fire and Flushing pumps	Before	After
#1	.004 .06	.001 .002
#2	.004 .08	.002 .007
#3	.001 .012	0
Fire and Flushing lines		
Fwd. eng. rm.	.005 .017	0
Aft. eng. rm.	.012	0

Encl. (E)

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Valve to magazine sprinklers

In C - 03	.001	0
	.005	.001
In C - 04	.001	.0
	.005	.001
Section of fire main in	1	
C - 03 (inside)	.008	0
	.15	.005
(outside)	.005	0

J. COLEMAN  
Monitor

Encl. (E)

SECRET

22 September 1946

MONITOR'S REPORT

DRYDOCK DECONTAMINATION

The USS LAFLEY docked in the ARD-32 at San Francisco Naval Shipyard has been undergoing hull sandblasting. To date sandblasting is only about 15 percent complete.

A preliminary study was made to determine the problems involved in decontaminating the deck of this dock.

An area was chosen near frame 140 of the ARD, which is the position of the USS LAFLEY's Propellers. Sandblasting had been carried out in this area on ship's sides as well as some chipping and scraping of the bottom and propellers. The deck of the ARD was covered with one-fourth inch of wet sand. A fifteen foot square area was swept down with brooms and radiation readings taken. This same area was next flushed with a fire hose for two and one-half minutes and readings again taken. Results are shown below.

- (a) Beta readings on 15 feet square area before removal of collected blast sand:

<u>R/24 hrs.</u>	<u>-X863</u>	<u>1/2 inch from source</u>
.000	.004	.004
.007	.004	.004
.005	.004	.004
.005	.004	.004
.005	.004	.004

Encl. (F)

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(b) after removal of collected blast sand with stiff brushes:

<u>R/24 hrs.</u>	<u>-X263</u>	<u>1/2 inch from source</u>
.007	.003	.003
.005	.003	.003
.004	.003	.003
.005	.003	.005
.004	.003	.003

(c) after flushing down for 2-1/2 minutes with fire hose:

<u>R/24 hrs.</u>	<u>-X263</u>	<u>1/2 inch from source</u>
.002	.0017	.0017
.008	.0017	.0017
.0015	.0017	.0015
.0015	.0015	.0015
.0015	.0015	.0015

Discussion:

On the area described above a section of the hauling block way was included. This afforded a check on crevices and irregular surfaces. Decontamination was equally effective here as on the flat rusty steel deck area.

A wooden keel block presenting a flat surface area four feet square was checked before and after a 2-1/2 minute fire hose flushing. The average surface reading in Beta R/24 hrs. before flushing was .008 and after flushing .002. The instrument background reading was .001. Hence, on wooden surfaces as might be expected decontamination is not as good as on steel decking.

Conclusions:

From results obtained on this test area, it appears that a short period, two and one-half minutes, of vigorous water flushing will result in excellent and satisfactory decontamination of steel drydocks.

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Encl. (F)

## LABORATORY TEST RESULTS

SAN FRANCISCO NAVAL  
SHIPYARD

8 October 1946

Report Number 383-4269-46

Material     The Effect of Decontaminating Solutions on the Water-Tightness of Valves.

1.           Four stock valves were selected and tested for water-tightness. Two of the valves were steel globe type and two were bronze gate valves. These valves were immersed in the various solutions listed below, removed, and tested hydrostatically, at the intervals listed in Table 1. The actual composition of the seats was not determined. One steel valve had steel seats while the other had bronze seats. The bronze valves had copper alloy seats. The temperature of the solutions varied between 60 and 80 degrees Fahrenheit.

2.           It appears that the addition of the inhibitor (Turco-Acrl, S. P.1) specification 51 I 2, Type B, Class a, in the concentration of 1% by volume of the amount of commercial Hydrochloric acid present gives satisfactory protection for a reasonable period of time. It is not recommended that uninhibited acid be used on steel valves. It should be pointed out that circulation will increase the action of the acid on valves.

3.           It is also recommended that additional or repeat tests be conducted on six valves. These valves should include three with steel seats and three with bronze seats, and that the solutions used should include ammonium citrate solution, in addition to inhibited and uninhibited hydrochloric acid. Pending the information to be obtained from this recommended test, it is the opinion of the laboratory that bronze and steel valves can be exposed to inhibited 1 normal hydrochloric acid for a period up to four hours without serious damage to the valves.

JOHN E. HOWELL  
Asst. Shop Supt for Laboratory

ENC: Table 1

G. M. GORDON

Enc. (3)

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TABLE I

<u>VALVE</u>	<u>SOLUTION</u>	<u>CHECK AFTER 4. Hrs.</u>	<u>CHECK AFTER 8 Hrs.</u>	<u>CHECK AFTER 26 Hrs.</u>	<u>CHECK AFTER 179 Hrs.</u>
BRONZE GATE	Hydrochloric Acid 1 N	Seepage at 100#	Seepage at 100#	Seepage at 100#	Small leak at 100#
BRONZE GATE	Inhibited Hy- drochloric Acid 1 N	Good at 100#	Seepage at 100#	Good at 100#	Small leak at 100#
STEEL GLOBE (Bronze Seats)	Inhibited Hydrochloric Acid 1 N	Good at 100#	Good at 100#	Good at 100#	Good at 100#
STEEL GLOBE (Angle)	Hydrochloric Acid 1 N	Good at 100#	Good at 100#	Good at 100#	Bad leak withheld no pressure

Observations as to conditions made by Lt. K. M. Culver,  
Ship Supt.

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SAN FRANCISCO NAVAL SHIPYARD  
SAN FRANCISCO 24, CALIFORNIA

C O N F I D E N T I A L

7 October 1946

From: Senior Bureau of Ships Crossroads Representative, San Francisco  
To: San Francisco Naval Shipyard  
Subj: Experimental Radiological Decontamination, USS ROCKBRIDGE (APA228)

1. The USS ROCKBRIDGE (APA228) will be decontaminated to accomplish the following results, if possible:
  - (a) Upon completion of the decontamination process, the vessel should be granted complete radiological clearance.
  - (b) The data taken during the work on the vessel should furnish the information necessary to arrive at a standard by which it may be determined:
    - (1) When it is necessary to decontaminate.
    - (2) When the decontamination process is complete.
  - (c) A firm procedure should be developed which may serve as a model for future ships and other Yards.
  - (d) All radiological safety precautions currently in force will be tested for their efficiency and pertinence.
2. Experience has shown that the following locations aboard ship contain all of the contaminants aboard non-target vessels.

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- (a) The exterior of the underwater body of the ship and small boat hulls.
- (b) The salt water system, firemain and flushing.
- (c) Evaporators, salt water sides, and piping.
- (d) Miscellaneous heat exchangers, using salt water as a cooling medium, such as lube oil coolers, freon condensers, boat engine cooling system, etc.
- (e) Main and auxiliary condensers.

The above grouping of the contaminated areas of the ship is made in view of the fact that each group requires a distinct treatment. The nature and extent of any contamination could be expected to be roughly the same within each group.

3. The steps in which the work will be accomplished on each system will be as follows:

- (a) Monitor each system completely. The senior monitor at the Shipyard is assigned the responsibility of outlining the procedure to be used that all readings taken and recorded may be identified. The procedure should be laid out and recorded in such a manner that it may be duplicated on any ship or by any monitor. The data that must be taken with each reading will be specified in consultation with the University of California Laboratory representative. The aim of the radiological survey is, in conjunction with the other data obtained, to prove that it is or is not practicable to grant complete radiological clearance on the basis of Roentgen readings alone.
- (b) Samples will be taken from each system. Where practicable they will be taken at the location of the highest readings for the particular system involved. In general they will be taken before and after decontamination, and of the materials removed.

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The samples with complete data will be delivered to the University of California laboratory for qualitative and quantitative analysis.

- (c) The Shipyard will estimate the total amount of materials similar to the samples on the ship.
- (d) The Shipyard, assisted by ship's force, will apply the approved decontamination procedure to the system. Upon completion, withdraw samples of materials removed and dispose of the remainder as per current instructions. During decontamination make an analysis of the methods employed to determine the safety precautions required.
- (e) Completely resurvey the ship in a manner similar to step (a) above. Resample as in (b).
- (f) On the basis of the above data, calculate for each system the amount of the contaminants present before and after decontamination and the amount removed.

The facts as ascertained will be forwarded to BuMed and BuShips with all pertinent recommendations.

4. Below for each system are enumerated amplifications and applications of the steps outlined above to each system:

(a) Hull exterior.

- (1) Complete survey. In the survey of the underwater body, it is desirable to obtain an accurate idea of the distribution of the contaminated area of the ship bottom. The data taken will include the following:
  - a. Condition of the paint
  - b. Thickness of the paint
  - c. Whether or not there is rust under the paint
  - d. Amount, distribution, and types of fouling.

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- (2) Taking of samples. The samples taken will consist of: Marine growth from a given area of the bottom showing the highest reading. From this same section in each case the paint will be carefully scraped off and also serve as a sample. Rusted areas which may show similar high readings will also be removed for a sample. Non-fouled painted areas showing the highest readings will be scraped off carefully as a sample.

The idea of the samplings and their subsequent analysis will be to determine, if practicable, if the decontamination procedure could be stopped after the removal of marine growth and/or possibly the removal of the rusted areas where no marine growth is present. Failing in this, answering the question whether or not it might be possible to decontaminate the ship by applying the wet sandblasting to specified and limited portions of the bottom.

- (3) The Shipyard will calculate or estimate the total underwater area of the ship and the amount of each sample present on the ship.
- (4) Decontamination, The Shipyard will
- a. Scrape the marine growth from the sides of the ship while wet.
  - b. Wet sandblast in the normal fashion.
  - c. Dispose of sand and marine growth removed.

During the sandblasting, the experiment using the filter queen or equivalent shall be repeated while working the worst contaminated areas to check on industrial safety. By use of the filter queen, an experiment will be conducted to determine if any hazard exists in allowing the bottom to become dry and material exfoliating due to wind. This may

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be done by allowing a rather small section of the bottom to become completely dry, fitting up the filter queen down wind from the dry area and then directing a compressed air stream against the dry ship with a force simulating a high wind and collecting any particles removed.

- (5) The resurvey will be made, in general following the procedure used on the initial survey. It will probably be impracticable to remove any samples after the sandblasting.
- (6) By the use of the data obtained in this process, it should be feasible to recommend to the Bureau of Medicine and Surgery a limit of Roentgen readings, which, if an uncontaminated ship should have, no drydock work would be necessary. By the use of the data obtained by the filter queen, a similar recommendation can be made relative to the current safety precautions. From the surveys and sampling, it should be determined whether or not it is feasible to wet sandblast small areas which show contamination and give complete radiological clearance.

(b) Salt water piping.

- (1) Radiological survey. Methods to be formulated as in paragraph 4(a)(1) above. The aim of the operation is to take scientific data whereby from readings taken on the outside of piping we may set a lower limit for determining the necessity of conducting any decontamination procedure.
- (2) Samples. The samples will be taken where possible in the most contaminated spots and will consist of:
  - a. Scale and marine growth
  - b. Suitable whole length of pipe
  - c. Samples of material, acid sludge mixture removed.

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- (3)
  - a. The Shipyard will furnish an estimate of the total amount of scale or marine growth present in the pipe lines.
  - b. An estimate of the interior surface area of the salt water system.
  - c. The Shipyard will also measure the amount of scale, marine growth and sludge removed from the salt water system by the acid treatment.
- (4) Decontamination. The decontamination procedure for salt water piping will be to fill the system entirely, including all branches showing any Roentgen reading above background with the ammonium citrate solution recommended by the University of California or the HCL solution. The selection will be made on the basis of the amount of marine growth present in the pipe lines. Suitable temporary areas will be employed to obtain a certain amount of circulation of the acid. Suitable instructions will be furnished by the Yard to the ship to enable the ship to assist in this process to the maximum extent practicable. The acid, together with any sludge removed from the pipe lines, will be drained, sampled, and measured before being readied for disposal.
- (5) The system will then be resurveyed and samples similar to those taken in (2) will then be taken and delivered to the University of California. With the use of these samples and the other data, an estimate will be made of the total amount of contaminants remaining.
- (6) The complete data will then be forwarded with recommendations to BuShips and BuMed relative to complete radiological clearance.

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- (c) Evaporators. The steps in decontamination of evaporators will follow the same pattern as outlined for the hull and the salt water system. The actual decontamination procedure to be followed will be that presently authorized by the Bureau. Sufficient samples will be taken to ascertain if it is feasible to clear an evaporator on the basis of Roentgen readings alone.
- (d) Condensers. The same data and samples will be taken on one main and one auxiliary condenser as for any other system. No decontamination other than that currently approved will be undertaken.
- (e) Heat exchangers. Same as evaporators.

W. S. MAXWELL  
Captain, USN

CC: Dr. Scott, U. of C. Laboratory  
Captain Walsh, 12th N.D. Med. Off.  
Captain Wirn, 12th N.D. Operations  
Captain Quarton, 19th Fleet Material Office

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Code No. (330)

SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, Calif.

18 October 1946

MEMORANDUM

Subject: Progress of Radioactive Decontamination at  
San Francisco Naval Shipyard.

- Enclosures:
- (1) Monitoring Survey of Underwater Body of  
USS ROCKBRIDGE on Drydocking (3 October).
  - (2) Monitor's Report of Experimental Sandblasting  
of Hull - USS ROCKBRIDGE (4 October).
  - (3) Estimate of Total Radioactive matter on  
USS ROCKBRIDGE - Information for (14 October).
  - (4) Report of Experiment in Decontamination of Under-  
water Body - USS ROCKBRIDGE (14 October).
  - (5) Report on Experimental Decontamination Work on the  
Salt Water Lines - USS ROCKBRIDGE (15 October).
  - (6) Decontamination of Evaporator Unit on USS WALKE  
(DD723) (15 October).
  - (7) Report on Decontamination of Evaporators -  
USS ROCKBRIDGE (16 October).
  - (8) Report on Experimental Decontamination of Auxillary  
Condenser on the USS BOTTINEAU (16 October).
  - (9) Decontamination of Condensers - USS WALKE  
(17 October).

1. The following ships which took part in the Bikini operation at  
present are at the San Francisco Naval Shipyard.

USS WALKE (DD723)	
USS LAFFEY (DD724)	Destroyer
USS BARTON (DD722)	Division
USS LOWRY (DD770)	71
USS O'BRIEN (DD725)	

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USS BOTTINEAU (APA235)  
USS ROCKBRIDGE (APA228)  
USS ROCKWALL (APA230)  
LST-881  
ACHOMAWI (ATF148)

2. Completed reports of work on the above ships are herewith enclosed. All ships are making lists of items and systems requiring decontamination, based upon the Radiological Safety Officer's monitoring of the ship. Such lists are being submitted as work requests. In the main the work requests call for material and equipment to be furnished by the Shipyard. All work is being performed by the ships, subject to inspection and advice from the Shipyard.
3. All decontamination work is progressing satisfactorily on ships of Destroyer Division 71. It is planned to have the first of these ships cleared by the Radiological Safety Officer by 22 October. A complete monitor list for the ship will then be submitted for final clearance.
4. The USS ROCKBRIDGE has completed the salt water mains, evaporators, and sandblasting. Readings and experimental samples, in accordance with instructions from the Bureau of Ships, have been submitted for study to the Research Radiation Laboratory at the University of California. From this data, a calculation will be made to determine the total amount of radioactive matter on the ship.
5. The USS BOTTINEAU is procuring blanks and equipment from the USS ROCKBRIDGE as soon as each item is finished, and is setting up for decontamination.
6. The USS ROCKWALL was furnished instructions, material, and equipment, and proceeded to sea on 16 October for decontamination of their salt water lines and evaporators. An experienced Ship Superintendent assisted the ship at sea. The USS ROCKINGHAM, berthed temporarily at the Shipyard, was similarly provided for. Both ships completed the work and returned to port after 30 hours.

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7. The LST-881 completed monitoring 17 October. Actual work of decontamination should start 21 October.

8. The ACHOMAWI (ATF-148), as shown by a complete monitoring survey, has less contamination than expected. All cordage, canvas, wood, boats, etc., was disposed of at sea. Only a few miscellaneous items have monitor readings significant enough to warrant experimental decontamination (2 fire hoses, paint, etc.). The salt water lines require considerable repair work before decontamination can proceed. The evaporator unit was not used at Bikini and shows no radioactivity. The ship is being listed this date to obtain waterline monitor readings. Dry-docking is scheduled for 21 October. Both the ACHOMAWI and the LST-881 will have the same samples taken as the USS ROCKBRIDGE to permit a detailed analysis to be made.

PHILIP LEMLER  
Captain, USN  
Production Officer

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October 3, 1948

Subject: Monitoring Survey of Underwater body of  
U.S.S. ROCKBRIDGE on Drydocking.

1. Readings taken in drydock as water was pumped out. Due to rapidity at which water receded, the availability of only one row boat, and the necessity for obtaining readings on both the ROCKBRIDGE and BOTTINEAU more extensive readings were not recorded. Only representative readings are listed. Readings were taken continuously but recorded at every 2nd weld alongside unless reading varied appreciably from surrounding areas. Hull was wet and readings were taken on contact with skin of ship at water line or slightly below.

	Gamma	Gamma plus Beta
Rudder and Screw	2 x background	.009
#1	2 x background	.008
#2 stbd.	background	.003
#3 stbd.	background	.007
#4	background	.002
#5 (heavy growth)	background	.007
#6	background	.003
Bow, (rusted area)	2 x background	.019
#7 (8 ft. below W.L.)	background	.012
#8 (Port)	background	.014
#9	background	.005
#10 (heavy marine growth)	background	.016
#11	background	.008
#12	background	.007
#13 (screw)	2 x background	.009
#14 (12 ft. below W.L. heavy rust area and marine growth about fr. 60	2 x background	.025
#15 (Sea strainer about Fr. 70) (Along keel and 2 feet water level stbd.)	2 x background	.040
Rudder and screw	background	.003
#16	background	.004
#17	background	.004
#18	background	.005

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Enc. (1)

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	Gamma	Gamma plus Beta
#19	background	.003
Stabilizing fin	2 x background	.03
#20	background	.007
#21	background	.006
#22	background	.005

2. Readings on hull will be 3-6 times higher when dry. See readings taken on experimental sand-blast area the following day.

3. Probably the most representative 20-ft. strip for experimental blasting would be on portside frame 50-70. The area should include a portion of the stabilizing fin. The readings in this area range from .007 to .03 (wet). When dry the readings will be approximately three times the above. The rust spots and areas with heavy barnacle formations approximate closely to the .03 reading.

Enc. (1)

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## MONITOR'S REPORT

4 October 1946

### EXPERIMENTAL SANDBLASTING OF HULL

#### USS ROCKBRIDGE

##### Experimental Set Up

A 20 x 20 ft. area on port side, previously determined as a representative of the worst condition available on hull of USS ROCKBRIDGE, was designated for the experiment. The area was monitored and 1 ft. sq. (surface area) samples taken at the waterline Frame 70, at sea strainer Frame 71 just above stabilizing fin, at heavily rusted area about Frame 60, 6 ft. water level, and Frame 63 at 10 ft. water level. The procedure used on collecting the samples was as follows:

- (1) 1 Sq. Ft. area marked off
- (2) Monitored for Beta plus Gamma
- (3) Superficial Contamination removed by scraping material collected
- (4) Monitored again for Beta plus Gamma
- (5) Deeper contaminated material removed to the metal and material collected.
- (6) Cleaned area monitored again for Beta plus Gamma

Sandblasting of the area was then carried out with a blower placed next to sandblaster so as to collect as much of the dust as possible in area of worker. Another blower was placed on deck of drydock to collect the dust, at that point. The material collected by these blowers was passed through a filter of glass wool which will be monitored subsequently and samples of dust sent to laboratory for analysis. An estimate of surface area covered by rust and heavy marine growth will be calculated by the repair superintendent's representative.

Following the sandblasting the area was monitored again to determine residual activity and samples taken.

SECRET

Enc. (2)

All samples will be analyzed at Radiation Lab. at University of California.

The following are the readings and descriptions of areas before sandblasting.

<u>Sample and Location</u>	<u>Description</u> (All samples taken from 1 sq. ft. area)	<u>Reading</u>
#1 Frame 70 waterline	Superficial scraping of rust	Before .192 Beta pl. Gamma After .048
#2 Frame 70 waterline	Deep scraping of rust and paint	Before .048 After .016
#3 Sea strainer Frame 71	Superficial scraping heavy marine growth and rust	Before .5 After .38
#4 Sea Strainer Frame 71	Rust and some marine growth	Before .38 After .31
#5 Frame 60 3 ft. above stabilizing fin.	Heavy rust and some marine growth Superficial scraping	Before .22 After .14
#6 same	deep scraping of rust and paint	Before .14 After .0050
#7 8 ft. below	superficial scraping light rust and fine Marine growth	Before .036 After .024
#8 same	deep scraping paint and some rust	Before .024 After .005

SECRET

Enc. (2)

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READINGS ON THE EXPERIMENTAL AREA AFTER SAND  
BLASTING WERE BACKGROUND B. AND G.

Following the sandblasting, samples of sand were taken from the areas on the drydock deck directly below the blasted area. These samples were Nos. 9, 10, and 11. Readings of this sand varied from .002 - .005.

The filters from the two suction blowers were sent to the lab. for analysis.

LT. E. W. BARNES (MC) USN

Enc. (2)

SECRET

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14 October 1946

Subject: Estimate of total radioactive matter on USS ROCKBRIDGE;  
Information for.

1. In order to make a calculation for total radioactivity on the ship,  
it was necessary to:

- (a) Take representative samples from various systems for study  
at the radiation laboratory and for determination of the total  
amount of radioactive matter in the samples.
- (b) Assign to each sample the area that it represents.
- (c) Provide the total area of contaminated surfaces on the ship.

2. Samples were taken in high reading spots in the system as follows:

<u>LOCATION</u>	<u>AREA REPRESENTED</u>
Elbow from Overboard of Auxiliary Condenser No. 2	30.
Valve from Lube Oil cooler inlet No. 1 generator	2.5
Elbow from overboard of Auxiliary condenser No. 1	35.
Valve from Lube Oil cooler No. 2 generator	2.5
Valve from Lube Oil cooler Inlet No. 2 Generator	2.5
Valve from Lube Oil cooler outlet No. 1 generator	2.5
Sea suction strainer No. 1 assembly	16.
Salt water manifold to refrigerator from No. 1 valve	1.5
Cut Off to reducing valve outlet 2-63	2.5
Sea Suction strainer assembly No. 2	16.
Cut Off to reducing valve outlet 2-63	2.5
Reducing Station, sanitary system from 2-97-1.	1.5
Sanitary system, Reducing valve, 2-63	6.
Connecting line between fire pump discharge manifold to refrigerator unit	2.
Evaporator, Unit #2, Second effect Unit #2, sump.	470.
Evaporator Unit, First effect Unit #2, sump.	470.
Evaporator Unit, No. 1, First effect sump	470.

SECRET

Enc. (3)

# USS ROCKBRIDGE

<u>LOCATION</u>	<u>AREA REPRESENTED</u>
Marine growth - underwater body - Fr. 70	20,000.
Barnacles " " Fr. 60	30,000
Rust " "	1300.
Sand in bottom of dock (after sample sandblasting)	125 Tons

3. Total contaminated areas for the various systems and other pertinent information necessary for application, of data from samples to the end that the total amount of radioactive matter on the ship might be estimated are given as follows:

Evaporator Plant  
1,880 sq. ft.

Main Condenser  
7,900 sq. ft.

Total Vertical Exterior  
surface exposed (superstructure)  
5,280 sq. ft.

Fire, flushing and cooling system  
22,800 sq. ft.

Total Horizontal Exterior  
surface exposed (superstructure)  
10,240 sq. ft.

Lube Oil Coolers  
407 sq. ft.

Auxiliary Condenser  
3000 sq. ft.

Total salt water surface - Interior  
35,888

Total exterior of Hull - Keel to top of bulwark  
70,000 sq. ft.

Enc. (3)

SECRET

**Weight and Volume of Marine Growth and Rust on Underbody  
of USS ROCKBRIDGE (APA228)**

		<u>Wt.</u>	
Barnacles	Keel up to 14' weight loading	2640#	30,000 Ft. <sup>2</sup>
Marine Growth	14' up to 16' Weight Loading	84#	20,000 Ft. <sup>2</sup>
Rust	16' up to 17' W.L. plus 1% of Hull	260#	1,300 Ft. <sup>2</sup>

**SAMPLES TAKEN:**

18 Ft. <sup>2</sup>	Barnacle scrapings weigh 349 grams -- .088#/ft. <sup>2</sup>	of hull scraped
6 ft. <sup>2</sup>	Marine Growth " " 56 " -- .042#/ft. <sup>2</sup>	" " "
6 ft. <sup>2</sup>	Rust " " 270 " -- .20#/ft. <sup>2</sup>	" " "

**CONDITION OF PAINT:**

Below Water Line - Poor  
 Above Water Line - Poor  
 Thickness of Paint - 1/32"  
 Rust - 1300 sq. ft.

LT. J. E. HOWELL

**SECRET**

Enc. (3)

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SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, Calif.

MEMORANDUM

14 October 1946

Subject: Report of Experiment in Decontamination of Underwater  
Body - USS ROCKBRIDGE

PURPOSE

The purpose of the experiment was a first attempt in an endeavor to find an easy, cheap method of removing contamination from the hull, if possible, without removing the paint.

METHOD

An area of the hull about three feet on a side was chosen which showed maximum activity. On 9 October (AM) each vertical half of this area received an application of a solution by brush. One solution consisted of 1N HCl, 5% CaCl<sub>2</sub>, and 20% starch; the other solution was ammonium citrate (pH solution 2 times strength), 5% CaCl<sub>2</sub> with starch to make a paste. Approximately 6 hours later the lower transverse half of the area was washed with salt water under pressure, readings before and after being recorded. The top transverse half was left alone until 11 October (AM) when it was washed down with salt water under pressure, readings again being taken before and after.

A small area was also outlined, for control, which received only the salt water wash down.

RESULTS

The results of the area receiving the chemical treatment are shown on the inclosed outline. The central area dropped from 0.032r/day to 0.017 r/day after the salt water wash down. Generally the chemical treatment did not appear to effect any greater reduction

SECRET

of activity than the plain salt water pressure wash. The citrate area in the upper right hand corner showed sufficient removal of contamination. However, in this case the starch solution had so hardened in standing for a day that it would not wash off and had to be removed by mild rubbing with a cloth. The indicated zero readings mean one to several times background.

#### REMARKS

The results indicate that the treatment with HCl is no more efficient than that using plain salt water. The citrate solution when removed immediately also showed the same level of effectiveness. However, when it had been allowed to stand and was rubbed off, marked reduction in activity occurred. If a citrate solution could be prepared that would stay wet when allowed to stand for a day it possibly would effectively reduce the activity.

The various readings were taken with the Model 263 Geiger Muller counter. The indicated differences in the readings at the various stages cannot be regarded as quantitative, in any degree, but merely reflect, qualitatively, that some reduction has occurred.

LT. J. E. HOWELL

LT. M. MALLORY, JR.

LT. G. C. CARTER

Enc. (4)

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1600 9 October 1946

USS ROCKBRIDGE (APA228)

Before Treatment

1600 9 October 1946

3'				3'				
.028	.055	.018	.012	.018	.021	.055	.020	.010
HC1 Brushed on		Citrate and Starch brushed on		HC1 Brushed on		Citrate and Starch brushed on		
.024	0.06	.023	.024	.28	.012	Washed salt water pressure		
.045	.06	.038	.034	.018	.056	.015	.015	

1000 11 October

Before Washdown				After Washdown			
.015	.04	.009	0	.01	.025	0	0
.03	.03	.03	.03	.01	.01	0	0
.025	.045	.008	.01	.009	.009	.009	.009

READINGS IN r/day

SECRET

SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, Calif.

MEMORANDUM

Subject: Report on Experimental Decontamination Work on the  
Salt Water Lines - USS ROCKBRIDGE (APA228)

Reference: (a) Estimate of Total Radioactive Matter on the  
USS ROCKBRIDGE - Information for

Enclosures: (A) Monitor's Report of Readings before and after  
Decontamination - USS ROCKBRIDGE.  
(B) Procedure used in Decontaminating Salt Water  
System of the USS ROCKBRIDGE.

1. In the decontamination of salt water lines on the USS ROCKBRIDGE,  
the following steps were completed as follows:

- (a) The system was completely monitored. In order to obtain in-  
side readings and samples, several valves were dropped.  
Readings are given in Enclosure (A).
- (b) Samples were removed from all points in the system which  
had been opened up. Measurements were made on the quantity  
of foreign matter at each point, so that an estimate could be  
made of the total amount of foreign material in the entire  
system. Samples and data were forwarded to Dr. Scott at the  
University of California. Details insofar as can be determined  
by the Shipyard are listed in reference (a).
- (c) The fire and flushing system was decontaminated. Samples of  
decontaminating liquids were delivered to the University of  
California. Details and procedure are given in Enclosure (B).
- (d) The system was resurveyed. The University of California is  
calculating the total amount of contamination present before and  
after decontamination and will forward their report separately.

Enc. (5)

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(ENCLOSURE (A))

Code No. (335)      SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, Calif.

15 October 1946

MEMORANDUM

Subject:      Monitor's Report of Readings before and after Decontamination of Salt Water Mains - USS ROCKBRIDGE (APA228)

1.      This report lists the results of the acid treatment in removing radioactivity from the salt water system of the USS ROCKBRIDGE. All readings were taken with the 263 G-M Counter. The external readings (outside of pipes, etc.) are measurements of gamma radiation only. The internal readings were taken with the tube in direct proximity to the active material so that it was exposed to the effect of beta radiation. It is well to note that the beta-gamma readings have no significance as far as the roentgen unit is concerned, but serve merely as a method of comparing the activity of an area in question before and after treatment.
2.      The external or gamma readings are difficult to interpret since they are measured on the very lowest part of the scale. This makes any decrease virtually impossible to measure accurately. That the overall activity has been reduced is definite, but in what proportion cannot be said from these readings alone.
3.      In the case of the internal or beta readings, we have in most instances a marked drop. Where these readings have been reduced to the level of 0.01 and below we can say that all significant activity has been removed. But, we definitely cannot say that any proportionality exists between total activity before and after and the roentgen figures before and after.
4.      It is the judgment of this monitor that in unbroken stretches of piping where good circulation of the acid occurred, 80% to 90% reduction in activity has been effected. In other sections of the system

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Enc. (6)

(ENCLOSURE (A))



(ENCLOSURE (A)) - Continued

where circulation was slow or non-existent, there is a lesser degree of effectiveness of decontamination.

5. All of the following readings are in roentgens per day. "Pb" is the symbol for "plug background" and "b" is the symbol for any "background" reading.

<u>ITEM</u>	<u>Before Decontami- nation</u>	<u>After Decontami- nation</u>
Strainer No. 1 F and F Pump	.110 beta	Pb
Strainer No. 2 F and F Pump	.140 beta	Pb
F and F Pump No. 1 water ends	.007 gamma	Pb
F and F Pump No. 2 water ends	.005 gamma	.002 gamma
F and F Pump (open line from)	.120 beta	.003
All discharge valves from F and F Pumps	.007 gamma	Pb
Flush lines to C-101-7L head	.006 gamma	.002 gamma
Flush box to C-101-7L head (inboard)	.007 gamma	.004 gamma
Flush box to C-101-7L head (outboard)	.008 gamma	.005 gamma
Head C-101-10L		
Flush box fwd.	.006 gamma	.002 gamma
Flush box inboard	.006 gamma	.002 gamma
All flush lines	.005 gamma	.002 gamma
Head B-202-A1	.004 gamma	.002 gamma
Flush box		
Head A-204-6	.004 gamma	.004 gamma
Fwd. Head stbd.		
Fwd. Head Port	.004 gamma	b gamma
Laundry	b	b
Fire Plugs (90%)	b	b

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Enc. (5)

(ENCLOSURE (A))

(ENCLOSURE (A)) - Continued

<u>ITEM</u>	<u>Before Decontami- nation</u>	<u>After Decontami- nation</u>
Fire Mains (General)		
2-37-1 (not lagged)	.030 gamma	.008 gamma
2-47-2 (lagged)	5 gamma	pb gamma
2-75-1 (lagged)	2b gamma	pb gamma
2-82-2	4 gamma	Pb gamma
2-78-1	4 gamma	Pb gamma
2-111-2	b gamma	b gamma
2-121-1	b gamma	b gamma
Magazine sprinkling lines	b gamma	b gamma

<u>ITEM</u>	<u>Ex- ternal (-gamma)</u>		<u>In- ternal (beta plus gamma)</u>	
	<u>Before</u>	<u>After</u>	<u>Before</u>	<u>After</u>
Sea suction strainer assembly #1	.009	Pb	.210	Pb
Sea suction strainer assembly #2	.009	Pb	.380	Pb
Cross-connection No. 1 and No. 2				
F and F pumps	.007	b	.340	Pb
Connection to refrigeration cooling	.003	b	.190	Pb
Pump discharge valve 5-92-4	.007	b	.400	Pb
Pump discharge valve 5-91-6	.006	b	.190	.03
Pump discharge valve 5-92-6	.005	b	.240	.001
Sanitary system reducer 2-97-1	.005	.043	.029	.2
(the above due to non-circulation at this point)				
Sanitary system reducer 2-97-3	.007	.003	.290	
Sanitary system reducer 2-63	.014	.008	.290	.05
Cut-off to 2-63 (inlet)	.009	.004	.240	.015
Cut-off to 2-63 (outlet)	.009	.004	.290	.015

Enc. (5)

SECRET

(ENCLOSURE (A))

Code No. (335)

SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, Calif.

15 October 1946

MEMORANDUM

Subject: Procedure used in Decontaminating Salt Water System  
of the USS ROCKBRIDGE - Report on

1. The following decontamination setup was made: A 500 gallon mixing tank was placed topside by No. 4 hatch. A reciprocating air pump was connected to take suction on the acid mixing tank, and hoses led from the pump to discharge into the strainers for both No. 1 and No. 2 fire and flushing pumps. A recirculating hose was run from a bow fire plug back to the acid mixing tank, and another hose from a stern fire plug to the acid mixing tank. The valve from the fire main to the refrigerator cooling system was scoured, inasmuch as the refrigeration condensers contained many dissimilar metals, and it was felt inadvisable to use the muriatic acid in such a system.

2. The following procedure was followed:

- (a) At 0720 the uninhibited muriatic acid solution at 1 normal was started into the system. The ship's crew worked forward and aft from the fire and flushing pumps, opening up each outlet until flow of acid started. It was necessary in this procedure to provide men working on outlets in compartments with breathing apparatus to prevent their being overcome by acid fumes.

The system was apparently full at 1030, and acid recirculation was commenced. As air pockets were purged in the various lines, it was found necessary to add more acid solution. 750 gallons were needed in this final filling, making a total of 3100 gallons to fill the complete fire and flushing system. Monitor readings taken throughout the recirculation process indicated "floating" readings throughout at about 1300.

**SECRET**

Enc. (5)

(ENCLOSURE (B))

(ENCLOSURE (B)) - Continued

- (b) Titrations in the recirculating tank showed the following:

Initial solution	0.92 Normal
After 3/4 hrs. circulation	0.55 Normal
After 2-1/2 hrs. circulation	0.48 Normal

- (c) During the acid circulation samples from three (3) fireplugs not in line with the direct recirculation flow were tapped for samples:

Aft fire plug	0.1 Normal
Midships fire plug	0.0 Normal
Fwd. fire plug	0.2 Normal

All fire plugs were therefore tapped and about two gallons removed to insure replacement of spent acid with fresh. It would appear advisable to move the recirculating hoses around to several outlets to avoid stagnant spots as found above.

- (d) At 1400 the ship's crew began draining acid from the lines. Again rescue breathing apparatus was necessary for those working below decks. Complete drainage was effected in 3-1/2 hours.
- (e) At 1745 the ship commenced filling the salt water system with fresh water, running the first flow from various outlets into the acid collecting tank, after which the outlets were flushed into the bottom of the drydock.
- (f) At 1900 the process of draining water from the mains was started. A neutralizer solution (three ounces per gallon solution of trisodium phosphate) was introduced at 2145, taking a total of two hours to fill the system. The neutralizer solution was let stand overnight.

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Enc. (5)

(ENCLOSURE (B))

(ENCLOSURE (B)) - Continued

(g) At 0800 flushing out with fresh water was commenced. Each outlet was run for at least 1/2 hour, taking a total of 28 hours for the complete final flushing.

3. The drainage system was not included as planned. The Shipyard in the work of inactivation is welding blanks with pipe outlets on all overboard drain-discharges. As each discharge is completed, the ship will decontaminate the associated drains. Very few of the ship's drains are in need of decontamination.

Enc. (5)

**SECRET**

(ENCLOSURE (B))

15 October 1946

Subject: Decontamination of Evaporator Unit on USS WALKE (DD723)

1. The procedure for decontaminating the evaporator (two effect, Griscolm - Russell) solo shell) on the USS WALKE is as follows:

a. Inhibited muriatic acid of initial concentration 1.24 normal was added until the evaporator unit was completely filled. This required a total of 950 gallons. After the filling was completed, the acid was recirculated by taking suction on the acid mixing tank with the circulating pump and discharging from the brine pump into the acid tank. After two hours of circulation the normality was checked at 0.64 and it was decided to stop acid circulation and carry on the following steps:

(1) Pump all acid into the disposal tank

(2) Flush with fresh water.

(3) Circulate neutralizer solution for 30 minutes

(two ounces of soda ash per gallon of water)

(4) Drain completely.

(5) Flush with fresh water for several hours.

2. The monitor readings follow:

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	<u>Before</u>	<u>After</u>
Inside first effect	0.10 beta 0.007 gamma	0.002 beta bkg.
Inside second effect	0.05 beta 0.002 gamma	0.001 beta 0.001 gamma
Air ejector cond.	0.003 gamma	bkg.
Cond. Cooler	0.007 gamma	bkg.
Feed Lines	-	0.001 gamma
Brine lines	-	0.001 gamma

Enc. (6)

**SECRET**

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16 October 1946

Subject: Report on Decontamination of Evaporators - U.S.S. ROCK-BRIDGE.

1. This decontamination was conducted on the same plan as other work on the U.S.S. ROCKBRIDGE - namely to obtain information for study by the University of California.

- (a) Complete monitoring
- (b) Quantitative sampling
- (c) Decontamination
- (d) Resurvey

2. Information on procedure and monitoring is given below. Results of the quantitative studies of Dr. Scott will be forwarded by him.

#### A - Procedure

An acid mixing tank was set up topside. From this an air pump took suction and discharged to the inlet side of the condensate cooler of each set. This plant consisted of two sets of double effect Foster Wheeler (20,000 gal/day) evaporators. Each set required 1500 gallons of acid solution for filling. When the acid filling of each set was complete the filling hose was disconnected and a jumper line was connected from the discharge side of the brine pump to the suction side of the circulating pump. Both pumps were run for rapid circulation.

The acid solution consisted of two parts commercial hydrochloric acid to fifteen parts water plus 0.02 parts of Specification 51-I-2 inhibitor. Acid circulation was carried on for four hours and fifteen minutes in the case of Evaporator No. 1 and three hours and forty minutes in the case of Evaporator No. 2.

Enc. (7)

**SECRET**



Only one reading was taken on Number 1 Evaporator, and after 2-1/4 hours circulation, the solution was found to test 1.25 normal.

Evaporator number 2 was tested as follows:

Initial solution	1.4N
After 1-1/4 hours circulation	0.91N First effect 1.12N Second effect
After 3-1/4 hours circulation	0.90N First effect 0.96N Second effect

After acid circulation the following steps were completed

- (1) Acid pumped into disposal container
- (2) Evaps flushed with fresh water
- (3) Circulation of neutralizer solution carried on for 30 minutes (two ounces per gallon of soda ash in fresh water)
- (4) Final complete flushing with fresh water

**B - Monitor's Survey of Decontamination of Evaporators -  
U.S.S. ROCKBRIDGE**

pb = plus background  
b = background

	before	after
#1 Evaporator unit		
First effect shell	.007 gamma	pb
Feed heater	.009 "	b
Inspection plate (sump)	.005 "	pb
Second effect shell	.005 "	pb
Inspection plate (sump)	.003 "	pb
Distiller cond. shell	.080 "	pb
" " head	.030 "	.030
Cond. cooler	.050 "	pb
Feed line	.029 "	pb
First effect inside sump	.190 beta	pb
Second effect inside sump	.050 beta	pb

**SECRET**

#2 Evaporator unit	before	after
First effect shell	.009 gamma	b
Sump plate	.006 "	
Feed heater	.009 "	b
Second effect shell	.006 "	b
Sump plate	.003 "	b
Dist. condenser	.050 "	*
Brine overboard	.006 "	pb
Cond. cooler	.060 "	pb
Feed line	.030 "	pb
First effect inside sump	.260 beta	pb
Second effect inside sump	.60 beta	.005
Back pres. valve, brine overboard	.000 gamma	.015

\* .003 gamma except one spot off scale. This will be opened for examination.

SECRET

16 October 1946

Subject: Report on Experimental Decontamination of Auxiliary  
Condenser on the U.S.S. BOTTINEAU

1. It was decided to conduct a test of decontamination on an auxiliary condenser using the boiler compound boiling out procedure specified normally for the fresh water sides on the U.S.S. BOTTINEAU. Connections were made to the salt water side of No. 1 auxiliary condenser for filling with a solution of fresh water and boiler compound in the proportions 1 lb. boiler compound to 10 gallons of fresh water. Steam connections were made. Boiling out was carried on for a period of 12 hours, after which the system was thoroughly flushed out with water. In the boiler compound solution removed from the condenser no activity was found, although the solution had apparently removed a considerable amount of sludge. Both heads of the condenser were dropped for inspection, and it was found that most of the scale and rust, particularly on the iron heads, was still there. Monitoring inspection of the condenser after decontamination showed that the process had accomplished very little. Monitor readings for this experiment are given below. Zincs had been removed before the first readings.

	before	after
Through shell	.072 gamma	.078 gamma
Injection line	.014 "	.014 "
Overboard line	.010 "	.010 "
Against tubes	.190 "	.144 "
	.48 beta	.384 beta

Most of the fouling which was present in the condenser before the process was in the form of hardened scale and rust which apparently was not chemically affected by the boiler compound and which was not mechanically loosened by the very slow circulation effected in the process of decontamination. While the condenser was open the tube sheets were inspected and appeared to be in good condition. For this reason a muriatic acid cleaning is believed adaptable for this type condenser.

Enc. (8)

SECRET

17 October 1945

Subject: Decontamination of Condensers - U.S.S. WALKE

1. Before designation of a decontamination method for condensers had been promulgated, the engineering personnel of the U.S.S. WALKE conducted a mechanical decontamination. This consisted of removing old zincs, cleaning foreign matter from the tubes by punching out, and then pressure washing the tubes and circulating lines. The monitor readings which follow indicate the effectiveness of this process:

#1 Main Condenser	Before	After
inside injection line	0.017 beta	.002
against tubes	0.025 beta	.001
#2 Main Condenser		
inside injection line	0.048 beta	0.012
against tubes	0.02 beta	0.005
#1 Aux. Condenser		
inside injection header	0.22 beta	0.065

Enc. (9)

SECRET

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Code 180

4 Nov. 1946

C-S(99) - (1)(180)

C-EN18/A2-11

Serial: 01661

**CONFIDENTIAL**

To: Commander, Western Sea Frontier, Federal Office Building,  
San Francisco, California.  
Commander, San Francisco Naval Shipyard,  
San Francisco 24, California.  
University of California, Berkeley, California  
Attn: Dr. J. G. Hamilton.

Subj: Radiological Decontamination Program - Development of.

Ref: (a) CNO Conf. Ltr. OP-602/cmf, Serial: 021P602(SC),  
S67-1 of 27 August 1946.

1. Reference (a) assigns to the Bureau of Ships, among other items, responsibility for developing methods and equipment for decontamination of ships of the Navy. The Bureau of Medicine and Surgery is assigned cognizance and responsibility for establishing safety tolerances and regulations in the radiological safety program for the Navy.

2. The most pressing radiological problem facing the Navy at present is the decontamination of the CROSSROADS non-target ships. the following statement of Bureau of Ships policy in connection with the handling of decontamination of these ships is promulgated for the information and guidance of the addressees.

(a) The Bureau of Ships will coordinate the efforts of all activities in the investigation and development of ship decontamination procedures, will promulgate to cognizant activities approved methods, and will furnish technical assistance as required in the development and accomplishment of the approved processes.

**SECRET**

C-S(99)-(1)(180)

C-EN28/A2-11

Serial: C1661

CONFIDENTIAL

(b) The ship decontamination measures approved and promulgated by the Bureau of Ships will be designed to reduce quantities of radioactive materials and radiation levels to standards prescribed by the Bureau of Medicine and Surgery for complete and unrestricted radiological clearance. All approved decontamination methods will include strict observance of radiological safety precautions considered necessary by the Bureau of Medicine and Surgery.

(c) By arrangement with the Manhattan District the services of the University of California laboratory group are available to the Navy for assistance in developing techniques, materials and procedures by laboratory investigation for removal of radioactive materials from contaminated portions of ships. The University will also make qualitative and quantitative analysis of contaminating material on ships under investigation and will submit information so obtained to the Bureau of Medicine and Surgery and the Bureau of Ships through their authorized West Coast representative, if available, to assist in establishing safe radiation limits for clearance and portions of ships requiring decontamination. All recommendations as to decontamination techniques together with supporting data will be forwarded to the Bureau of Ships for approval, through its West Coast representatives, if available, otherwise to the Bureau directly.

(d) Naval Shipyard San Francisco will expand the laboratory procedures developed by the University of California and from the data obtained will work out suitable practical methods for application to ships. Personnel and equipment to augment the facilities of Naval Shipyard San Francisco to expand the radiological decontamination development work are under consideration. The Shipyard will maintain close liaison through a designated representative and work in conjunction with the University of California supplying information and appropriate samples of material to enable the university laboratory to conduct its research and analysis work effectively. Procedures for

SECRET

C-S(99)-(1)(180)  
C-EN28/A2-11  
Serial: 01661

CONFIDENTIAL

removal of radioactive materials from ships as developed by Naval Shipyard San Francisco will be submitted to the Bureau of Ships for approval prior-to general application to vessels.

3. The policies outlined above are concurred in by Manhattan District and the Bureau of Medicine and Surgery.

C. D. Wheelock, Rear Admiral, USN  
Deputy and Ass't Chief of Bureau

CC:  
CNO  
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**SAN FRANCISCO NAVAL SHIPYARD**

**SAN FRANCISCO 24, CALIFORNIA.**

**CONFIDENTIAL**

**14 November 1946**

**MEMORANDUM**

**Subject: Decontamination of Auxiliary Condensers.**

**1. The following observations are summarized:**

- (a) In auxiliary condenser systems copper nickel throughout.**  
For auxiliary condenser systems composed of copper nickel pipe, copper nickel heads, tubes and tube sheets, the use of 1/2 normal muriatic acid circulated for a period of one hour has proved sufficient to accomplish decontamination. This has been evidenced both in cases in which the condensers had previously been boiled out with boiler compound and in condensers having no previous treatment.
- (b) In condenser systems composed of the combination of ferrous and non-ferrous, as in the typical Maritime Service ships:**
  - (1) Circulation of 1/4 normal acid for a period of one hour has accomplished no results.**
  - (2) Boiling out with boiler compound has accomplished no results.**
  - (3) Circulation with 1/2 normal acid for a period of one hour has accomplished only 25% reduction in radioactivity.**
  - (4) Manual cleaning consisting of tube punching and scraping of heads followed by thorough flushing out with acid has accomplished sufficient decontamination. However, this**

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does not necessarily decontaminate pipe systems leading to and from the condensers. These would have to be decontaminated separately using one normal acid for any salt water system.

(5) The method appearing to be the most thorough is as follows:

- a. Remove heads and scrape as much rust off as possible from the heads.
- b. Reassemble.
- c. Hook up the acid circulation in such a manner that the auxiliary condenser circulating pump can be run taking suction on sea water so as to provide thorough flushing. In general, thermometer and pipe lead off connections are available for acid connection.
- d. Run one-half normal muriatic acid through the condenser for a period of one hour.
- e. Drain, start circulating pump and thoroughly flush for several minutes.
- f. Monitor the injection in overboard lines:
  - 1- If lines are above tolerance repeat above acid cleaning.
  - 2- Continue procedure until overboard and injection lines are within tolerance limits.
  - 3- Then check the condenser itself and accomplish any remaining decontamination necessary by manual cleaning. If necessary, the heads may have to be removed and filled with acid until heads are below tolerance.

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LABORATORY REPORTS  
OF  
EXPERIMENTAL WORK

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File (380)

SAN FRANCISCO NAVAL SHIPYARD

San Francisco 24, California

26 September 1946

MEMORANDUM LABORATORY TEST REPORT - PRELIMINARY

Subj: De-Contamination

1. 50 gallons of 1 Normal solution of Hydrochloric Acid, uninhibited, was circulated through a section of iron fire main aboard the USS HENRICO (APA45). Upon completion of the cleaning operation it was desired to estimate the quantity of rust and scale removed. A sample of the final solution was tested and found to contain 1.02% of ferrous oxide and 1.14% of calcium carbonate. These percentages indicate 4.8 pounds of calcium carbonate and 4.3 pounds of iron oxide were removed from the section of pipe. In addition to the salts dissolved in the solution it is estimated that approximately one pound of iron oxide was also present as a sludge.

JOHN E. HOWELL  
Asst. Shop Supt for Laboratory

GEORGE M GORDON  
Yard Chemist

CC: 300  
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335 (for Captain Maxwell)  
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File (380)

SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, California

MEMORANDUM LABORATORY TEST REPORT, PRELIMINARY

26 September 1946

Subject: De-Contamination

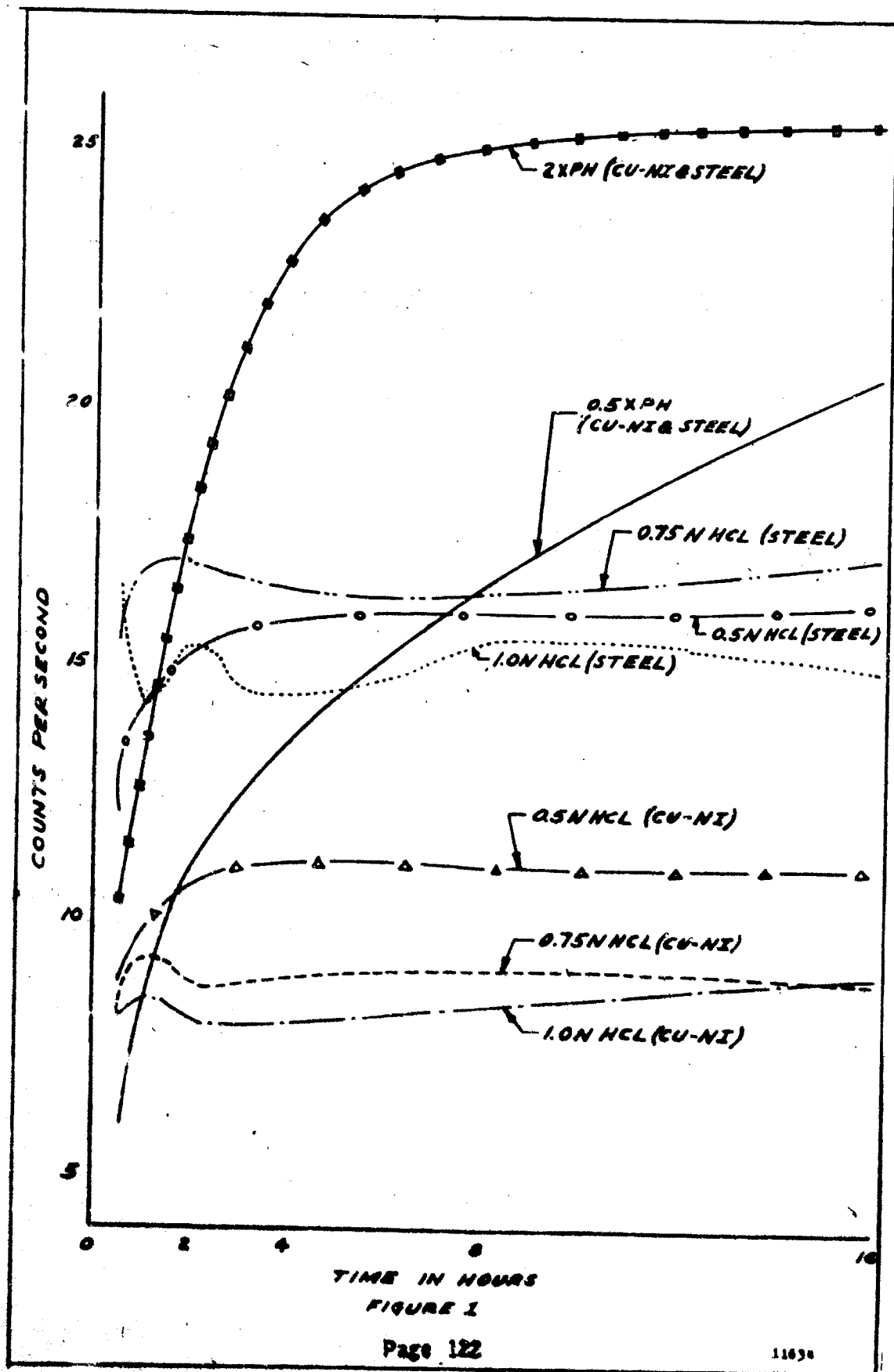
1. One section of copper-nickel pipe from the USS LAFLEY (DD724) and a section of steel pipe from the USS BOTTINEAU (APA235) salt water systems were selected and cut into test specimens. Radioactivity readings were made and the samples immersed in the following solutions: 1/2, 3/4 and 1 Normal uninhibited Hydrochloric Acid, and 1/2 and 2 times strength Ammonium Citrate buffer solution. Radioactivity readings of the solution were made over a period of time and the increase in radioactivity is shown in Figure 1.
2. Single strength buffer solution is prepared by mixing 24 pounds of Citric Acid and 17 pounds of 28% Ammonium Hydroxide and diluting to 50 gallons with water. The pH is adjusted to 6.0. A double strength buffer solution is the same weight of chemicals diluted to 25 gallons with water.
3. The readings are relative, as time requirements made it impossible to attempt to convert them to an absolute basis. There was no time, for example, to evaporate samples to dryness to correct for mass. The data show increase in radioactivity in the solution with time.
4. It can be assumed that when the activity in solution ceases to increase, the optimum time of contact with the given solution has been reached. This optimum time, found under laboratory conditions, is taken to be the least time of contact for that solution to give effective results. It should be pointed out, however, that circulation of the solution in contact with radioactive material in practice could be expected to cut down this optimum time, as determined in a still solution in the laboratory.

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File (380)

SAN FRANCISCO NAVAL SHIPYARD

San Francisco 24, Calif.

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26 September 1950

MEMORANDUM LABORATORY TEST REPORT (Preliminary)

Subject: De-Contamination

1. Two ten foot sections of fire main, one copper-nickel from the USS LAFFEY and one iron from the USS BOTTINEAU (APA235) were fitted with flanges on both ends and connected on one end so as to permit steam, water or air to pass through the pipe. Radioactivity measurements were made at various locations along the length of the pipes.
2. Steam was passed through the pipe until the surface temperature on the outside was approximately 180°F as measured with a Surface Pyrometer. When this temperature was obtained the steam was secured and cold water (60°F) was immediately forced through the pipe until the surface temperature dropped to 60°F (the time required for heating or cooling the pipe was in the order of 30 seconds.) Air was then blown through the pipe to remove the water, and the flanges were removed and radioactivity readings again taken.
3. The entire process was then repeated as in the above paragraph. Results of readings by the monitors are as follows, in roentgens for 24 hours:

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Iron Pipe				Copper Nickel Pipe			
Test location	Initial Reading	1st shock	2nd shock	Test location	Initial Reading	1st cycle	2nd cycle
inlet	0.4		0.08	3' from inlet	0.007	0.002	B G
1 ft from inlet	0.008	0.002	0.002	4-1/2' " "	0.009	----	B G
2 ft from inlet	0.07	0.003	0.002	5-1/2' " "	0.012	0.002	B G
3 ft from inlet	0.05	0.003	0.002	7' " "	0.014	0.003	0.003
4 ft from inlet	0.07	0.003	0.002	8' " "	0.012	0.003	B G
5 ft from inlet	0.07	0.003	0.002	9' " "	0.008	0.003	B G
6 ft from inlet	0.05	0.003	0.002	10' " "	0.007	0.003	B G
7 ft from inlet	0.05	0.003	0.002	Discharge	0.20	0.04	0.06
8 ft from inlet	0.05	0.003	0.002	Pipe temp		190°F	210°F
Discharge	0.5 +	0.01	0.01				
Pipe temp		150°F	210°F				

B G equals Background Rating

4. All radioactivity readings were taken with a Type X-263 portable instrument. The original copper-nickel pipe contained a large quantity of marine growth, whereas the steel pipe contained only rust and scale approximately 1/8" thick, all the marine growth was removed from the copper-nickel pipe with the exception of a small patch (approximately 2-1/2" by 5") located 7 feet from the inlet end of the pipe. At the completion of the test the pipe was cut so as to better reveal the remaining marine growth. The radioactivity measurement of this growth was 0.08. One other cut was made through the clean section of this pipe, its radioactivity reading was 0.007. Photographs were taken during and after the tests and will be forwarded under separate cover.

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SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, Calif.

26 September 1946

MEMORANDUM LABORATORY TEST REPORT, PRELIMINARY

Subj: De-Contamination

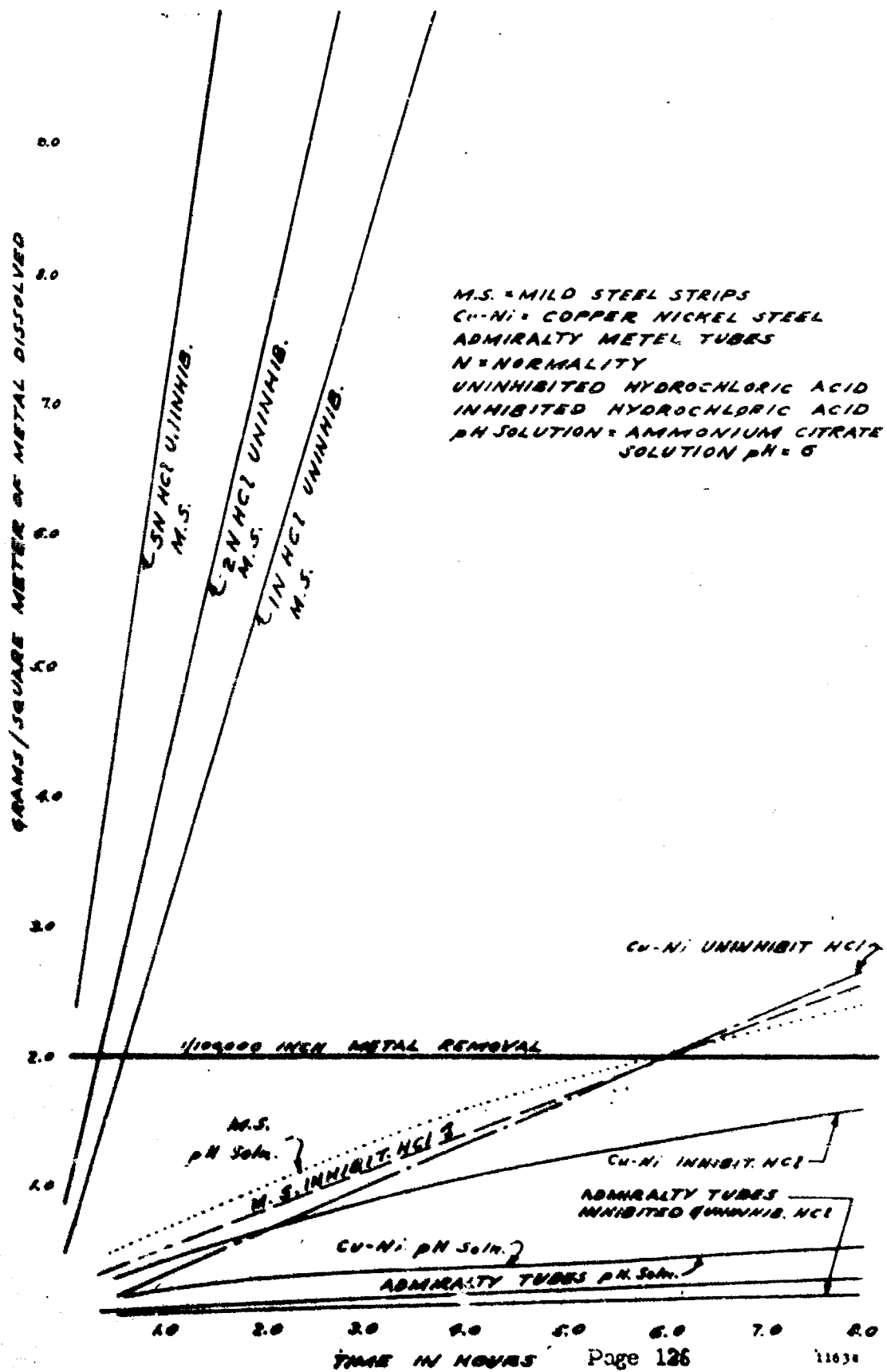
1. A series of tests were conducted to determine the attack of various solutions on metals normally present in salt water systems. The test specimens used were 1/2" x 3" x 1/16" copper-nickel and mild steel strips, and 3" sections of admiralty metal evaporator tubes.
2. The solutions used were (a) 1, 2, and 5 Normal uninhibited Hydrochloric Acid, (b) 1, 2, and 5 Normal inhibited Hydrochloric Acid, and (c) 1/2, 1, 2 and 4 times strength Ammonium Citrate buffer solution. The specimens were completely immersed in the solutions without agitation and at room temperature. They were removed and weighed at the intervals shown on the accompanying graph.
3. Single strength buffer solution is prepared by mixing 24 pounds of Citric Acid and 17 pounds of 26% Ammonium Hydroxide and diluting to 50 gallons with water. The pH is adjusted to 6.0. A double strength buffer solution in this same weight of chemicals diluted to 25 gallons with water.

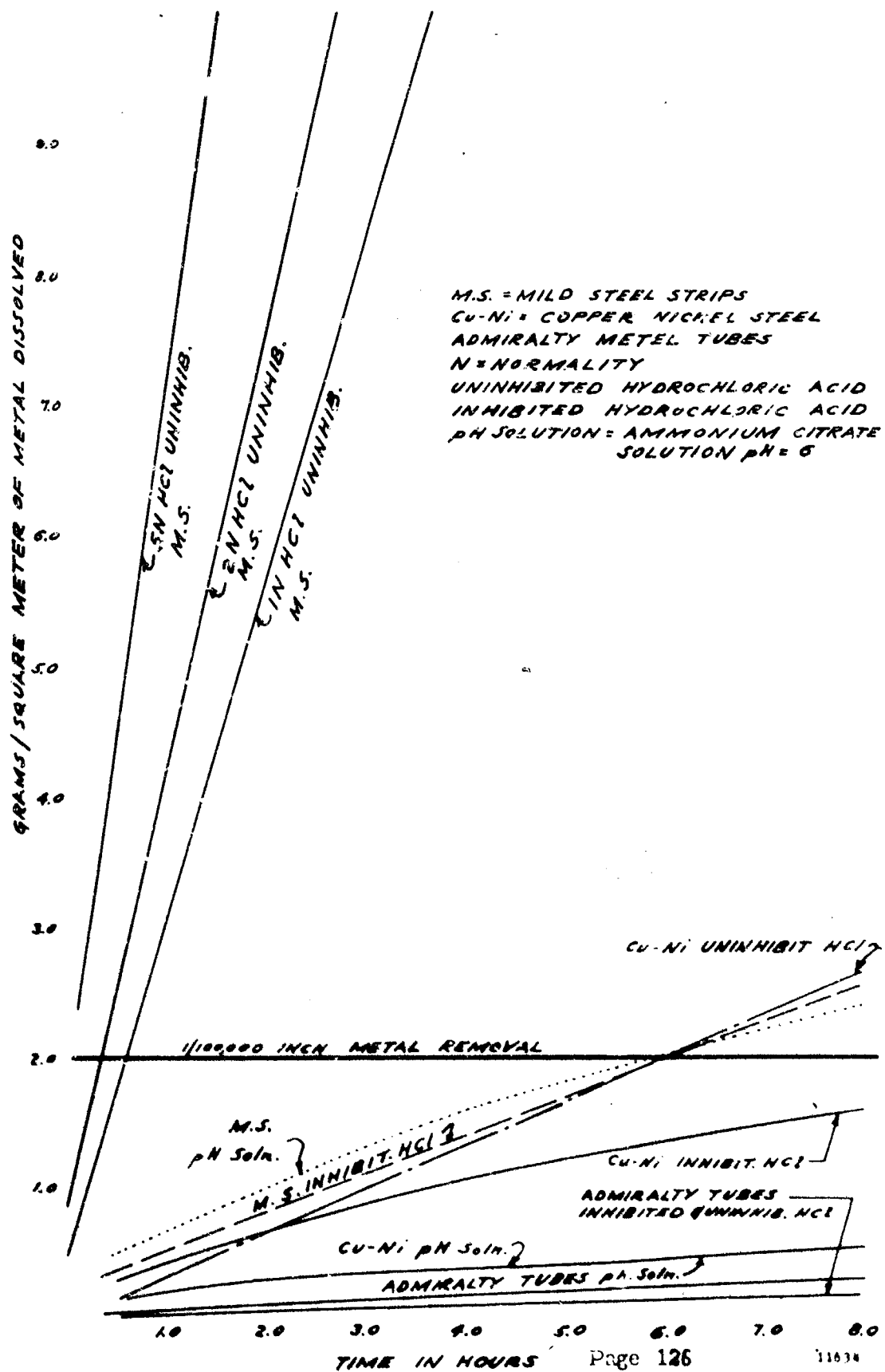
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SAN FRANCISCO NAVAL  
SHIPYARD  
SAN FRANCISCO 24, CALIFORNIA

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26 September 1946

MEMORANDUM LABORATORY TEST REPORT (Preliminary)

Subj: Report on De-Contamination of Valves.

1. Ten valves of various sizes were processed in Ammonium Citrate buffer solution to determine the rate of radioactivity removal by this solution.
2. The valves were obtained from the salt water system of the USS LAFFEY (DD724), the tests were conducted on the fantail of the ship. The solution was prepared by mixing 192 pounds of commercial grade Citric Acid and 136 pounds of 25% commercial Ammonium Hydroxide and diluting to 100 gallons. The pH of the solution was adjusted to 6.0. Radioactivity readings were taken by Monitors using a Type X-263 portable instrument. The valves were then immersed in solution for the intervals listed below. At the designated intervals they were removed and radioactivity readings again made by the Monitor. After each reading they were replaced in the solution until time for the next reading. The valves were not rinsed prior to the taking of the readings.
3. Results of the readings on the ten valves are as follows:

	<u>TOTAL HOURS</u>						<u>VALVE NUMBER</u>			
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
0	0.01	0.21	0.008	0.28	0.29	0.29	0.15	0.01	0.36	0.045
1	0.002	0.005	0.006	0.017	0.005	0.009	0.009	0.002	0.007	0.005
2	0.002	0.005	0.005	0.012	0.002	0.007	0.007	0.002	0.005	0.005
4	0.002	0.002	0.005	0.007	0.002	0.007	0.007	0.002	0.005	0.005
8	0.002	0.002	0.005	0.005	0.002	0.005	0.005	0.002	0.002	0.004
16	0.002	0.002	0.003	0.005	0.002	0.005	0.005	0.002	0.002	0.004

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Readings are Roentgen units in 24 hours.

4. Photographs of the tests will be forwarded under separate cover.

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SAN FRANCISCO NAVAL SHIPYARD  
San Francisco 24, California

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26 September 1946

DECONTAMINATION OF RADIOACTIVITY  
FROM SALT WATER PIPING

Purpose: To effect procedures to successfully decontaminate radioactivity from salt water piping of vessels present at Bikini - Test Baker.

Procedure:

- (a) Use of pH6 solution (Citric Acid and Ammonium Hydroxide).

On 14 September 1946 at 1100, a section of firemain on the USS LAFFEY was pumped full of pH6 solution (Citric Acid and Ammonium Hydroxide) and was allowed to stand for 72 hours until 17 September 1946 at 1100, at which time it was blown out.

An air hose was attached to one end of the firemain and a hose led from the other end to a steel barrel on the main deck, and the firemain was blown clear.

The barrel of solution showed radioactivity (.010) and was taken to the Industrial Laboratory for arrangements for disposal.

After the firemain was blown clear of the solution, the air service was disconnected and a fresh water main connected to the firemain. The hose at the outlet was led to a second barrel for examination of the first amount of flushing water. This water was found to be practically free of emission, and the discharge hose was led into the Bay. Flushing operations continued overnight.

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## RESULTS:

## GIEGER READINGS

### OUTSIDE OF PIPE

Before      After

.02            .007  
.017           .006  
.012           .005  
.008           .003  
(Background .002)

### INSIDE OF PIPE

Before      After  
.05      .5      .008      .06

Note: Each of these readings occurred in several places along the pipe.

The Citric Acid and Ammonium Hydroxide - pH6 solution was effective in removing about 90% of the radioactivity.

It was not effective in removing marine growth, a very little barnacle and scale was removed.

#### (b) Use of Hydrochloric Acid - 1% normal solution.

A 50-ft. section of copper-nickel salt water piping on the USS LAFFEY was blanked off and furnished with hose connections at each end. A reservoir in the form of a 50-gallon steel barrel was set up and filled with a 1.08% normal solution of Hydrochloric Acid. The acid was pulled from the reservoir through a reciprocating air pump to the blanked off section of piping. (This section had been flushed with fresh water for 30 minutes previously.)

Within a matter of minutes after the start of the acid circulating operation, the drum solution began to show radioactive emission.

At the end of eight hours, the acid content had levelled off to about 0.45% normal, and 45 minutes later the acid circulation was stopped.

The section of piping was then blown clear of acid with air, all of the acid being collected in the acid barrel.

One and one-half hours later, flushing operations with fresh water were started. The first barrel of flushing water showed radioactivity and was

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saved for disposal at sea. The second barrel was safe and the hose was led overboard to the Bay. Fresh water flushing was continued for one hour and ten minutes.

A second acid circulating phase was begun with an .88 concentration of hydrochloric acid and continued for four hours. Fresh water flushing operations were performed for 45 minutes

# RESULTS:

## GIEGER READINGS

<u>OUTSIDE OF PIPE</u>			<u>INSIDE OF PIPE</u>		
<u>Before</u>	<u>After 1st phase</u>	<u>After 2nd phase</u>	<u>Before</u>	<u>After 2nd Phase</u>	
.08	.007)		.5 .2	.001	.002
.07	.007)		.3 .08	.001	.002
.05	.007)	- Reduced to Background (.001)			
.03	.002)				
.02	.002)				
.01	.002)				
(.036	.029				
(.024	.021				
(.010	.017				

Between flanges, upward slant, dead end.

98% of radioactivity was removed.

100% of marine growth and scale was removed.

- (c) Use of pH6 solution (Citric Acid and Ammonium Hydroxide) on iron pipe.

On 18 September 1946 a section of iron pipe on the flushing system of the USS HENRICO was pumped full of pH6 (citric acid and ammonium hydroxide) and was allowed to stand for 72 hours, after which time it was blown out.

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The barrel in which the solution was collected was kept until arrangements could be made for disposal.

Fresh water flushing was continued overnight.

RESULTS:

GEIGER READINGS

<u>OUTSIDE OF PIPE</u>		<u>INSIDE OF PIPE</u>			
<u>Before</u>	<u>After</u>	<u>Before</u>		<u>After</u>	
.014	.002	.012	.5	.003	.08
.012	.003				
.008	.002 (Background				
.005	.002 (.002)				

Scale was still present in about the same amount as before.

(d) Use of Hydrochloric Acid - 1% normal solution, on iron pipe.

On 18 September 1946 a section of iron pipe on the USS HENRICO was blanked off and furnished with hose connections at each end. A reservoir in the form of 50-gallon steel barrel was set up and filled with a 1% normal solution of hydrochloric acid. The acid was pulled from the reservoir through a reciprocating air pump to the blanked off section of piping.

The acid circulation was started and continued for about eight hours.

The pipe was then flushed with fresh water for about 1 hour.

RESULTS:

GEIGER READINGS

<u>OUTSIDE OF PIPE</u>		<u>INSIDE OF PIPE</u>			
<u>Before</u>	<u>After</u>	<u>Before</u>		<u>After</u>	
.02 (		.008	.4	.002	.008
.017 (		.007	.34	.002	.008
.012 (	Reduced to				
.008 (	Background				
.005 (	(.002)				
.003 (					

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Practically all of the scale was cleared up in the operation except for a little loose scale at one end.

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SAN FRANCISCO NAVAL SHIPYARD  
SAN FRANCISCO 24, CALIFORNIA

S E C R E T

30 September 1946

MEMORANDUM TO: THE COMMANDER

Subject: Study of Decontamination of Salt Water Lines Based Upon  
Experimental Information to Date.

1. This study is made for the purpose of assembling information for examination at a conference of Shipyard, BuShips, BuMed and University of California representatives in order to determine the type and strength of solution that should be recommended to BuShips for use in removing radioactive matter from the salt water systems aboard BIKINI ships.
2. The information contained herein is a summary of facts drawn from the experimental work on decontamination of salt water lines conducted at San Francisco Naval Shipyard. Where pertinent, explanatory notes are included to explain the limitations of the data included.
3. Before a recommendation can be reached on the minimum strength solution and minimum time of use, the following must be resolved to form the basis for decision:
  - (a) The lower limit of radioactivity that must be reached in decontaminating a salt water system.
  - (b) The extent that scale and sea growth must be removed in the decontamination process.
  - (c) The extent to which damage may be allowed to valves, pumps, and piping in the salt water system.

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4. The following experimental work and results therefrom are available to date:

- (a) Tests for decontaminating salt water lines by means of flushing with salt water, saturated solution boiler compound and fresh water, saturated solution boiler compound and salt water, have all shown such negative results as to be excluded completely in this study.
- (b) Test of thermal shock on radioactive and badly fouled sections of pipe. Each of the pipe sections was provided with an inlet manifold to which was connected steam, cold water, and air. Steam was passed through the pipe until the temperature reached 180°F. The steam was turned off and water turned on simultaneously. As soon as the temperature of the pipe dropped to normal the water was cut off and the pipe blown out by air.

Results follow:

CuNi pipe (10 ft. length)	<u>Before</u>		<u>After</u>
	Outside highest	0.014	0.003
	Inside	0.20	0.06
	Heavy Marine growth throughout		All growth removed except one patch 2"x 5".
Fe pipe (10 ft. length)	<u>Before</u>		<u>After</u>
	Outside highest	0.07	0.003
	Inside greater than	0.5	0.01
	Heavy scale		Scale not appreciably affected.

(c) Tests involving ammonium citrate and muriatic acid solutions:

- (1) USS LAFLEY copper nickel lines containing large amounts of marine growth:

Circulation of muriatic acid solution. A 50 ft. test section copper-nickel main was circulated for six (6) hours with an

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initial concentration of 1.08 normal solution muriatic acid. Rapid circulation was carried on for 6 hours and 45 minutes, after which the main was blown out and cleared by flushing with fresh water. A second acid circulation phase was an initial concentration of 0.88 normal which was carried on for four (4) hours. The second phase showed little drop in normality of the acid, and it was concluded that the second phase was unnecessary.

RESULTS: All sea growth was removed. Removal of radioactivity matter is summarized as follows:

<u>Muriatic Acid solution 1 Normal</u>	<u>Before</u>	<u>After</u>
Outside of pipe readings	.005 to 0.08	.000 to .007
Inside of pipe readings	(.08 to .2	.000 to .002
	(.3 to over .5	.000 to .002

- (2) USS LAFFEY copper nickel lines containing large amounts of marine growth.

A solution of double strength ammonium citrate was introduced into a 50 ft. length of fire main and allowed to stand for 72 hours. This solution was made by mixing 48 lbs. of citrate acid and 34 lbs. of ammonium hydroxide to 50 gallons of water. After removal of ammonium citrate solution, this line was flushed with fresh water.

RESULTS: An estimated 30% of sea growth was removed. Removal of radioactive matter is summarized as follows:

<u>Ammonium Citrate solution pH6.0</u>	<u>Before</u>	<u>After</u>
Outside of pipe readings	.008 to .020	.000 to .007
Inside of pipe readings	.15 and over .5	.008 to .1

- (3) USS HENRICO steel lines, containing small amount of sea growth and large amount of scale:

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Circulation of muriatic acid solution. Approximately 50 ft. test section of steel flushing main was treated with six (6) hours of muriatic acid circulation (1 normal). Upon completion of acid circulation the line was cleared by flushing with fresh water.

RESULTS: All scale was removed. Removal of radioactive matter is summarized as follows:

<u>Muriatic Acid solution 1 normal</u>	<u>Before</u>	<u>After</u>
Outside of pipe readings	.002 to .02	.000
Inside of pipe readings	.007 and .4	.000 and .008

A sample of the circulated acid solution was removed from the pipe in order to estimate the types and quantities of matter removed:

IN SOLUTION - 4.8 lbs. calcium carbonate  
4.3 lbs. iron oxide

SLUDGE - 1 lb. iron oxide

- (4) USS HENRICO steel lines containing scale and small amount of sea growth.

A solution of double strength ammonium citrate was introduced into the line and allowed to stand for 72 hours, after which it was cleared and the line was flushed with water. This solution was made by mixing 48 lbs. of citrate acid and 34 lbs. of ammonium hydroxide to 50 gallons of water.

RESULTS: The scale inside the pipe was not appreciably affected. Removal of radioactive matter is summarized as follows:

<u>Ammonium Citrate solution pH6.0</u>	<u>Before</u>	<u>After</u>
Outside of pipe readings	.002 to .014	.000 to .003
Inside of pipe readings	.012 and over .5	.000 to .08

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(5) USS BENEVOLENCE. On the BENEVOLENCE a 16" steel cross-over line forming the lower suction for the three auxiliary condensers showed such high readings as to prohibit the ship from sailing. These readings ranged from 0.1 to 0.9 gamma. This line was treated as follows:

a. Steam injected into section until the temperature of the line reached 170°F., at which time the main was flooded with cold water (cold shock). RESULTS: Negative.

b. Same as above. The temperature was allowed to reach 195°F.

c. A 2 normal muriatic acid solution was injected into the main and slowly circulated for 1 hour and 40 minutes. The section of line was then flushed with salt water for five minutes, then drained and subsequently flushed with a neutralizing solution containing soda ash. The readings after this treatment ranged from .005 to .070 gamma.

(6) A condensate cooler from the USS BENEVOLENCE was filled with a 1 normal inhibited solution of muriatic acid and let stand for one hour. The reading reduced from 0.25 to 0.03.

(7) Nine valves from the USS BENEVOLENCE evaporator brine and overboard lines were treated by dipping and scrubbing in a twice normal inhibited solution of muriatic acid. Time to reduce readings to background varied from 10 to 30 minutes, the time appearing to be a function of the Geiger readings.

Readings before:	0.012
Readings after:	0.006

No visual signs of attack on the valve and valve seat metal could be noted.

Those results could have been bettered by dismantling all valves. Those dismantled showed final readings at 0.000.

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It should be noted here that the valves contained radioactive matter in the upper portion of the bonnet. Such surfaces require longer than the short period of this test for complete decontamination because the flushing action following the acid treatment does not reach into the recesses to wash out the loosened foreign matter. Conclusions from tests on straight runs of pipe to determine the minimum time for decontamination must be modified to allow additional time for more complete acid reactions in the recesses when the piping system is considered as a whole.

- (8) Tests were conducted on ten CuNi valves in a solution of ammonium citrate with pH 6.0 but with twice the strength of the original test solution on the USS LAFFEY. The present test solution was in the proportions: 24 lbs. Citric Acid; 17 lbs. Ammonium Hydroxide; 12.5 gals. water, and is designated as 4 strength.

VALVE NUMBERS - all readings are Beta

Hours Immer- sed	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>
0	0.010	0.210	0.008	0.230	0.290	0.290	0.150	0.010	0.290	0.045
1	.002	.005	.006	.017	.005	.005	.009	.002	.007	.005
2	.002	.005	.005	.012	.002	.005	.007	.002	.005	.005
4	.002	.002	.005	.007	.002	.005	.007	.002	.005	.005
8	.002	.002	.005	.005	.002	.0012	.005	.002	.005	.005

Here again, complex assemblies take longer than is indicated by laboratory tests on simple formed samples. Most removal of radioactive matter is accomplished in one (1) hours. However, in this 4 strength ammonium citrate four (4) hours were necessary before every valve showed reading below 0.01 Beta.

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- (9) Test samples of copper nickel and steel pipe were treated in the Laboratory with various strength solutions of hydrochloric acid and ammonium citrate. The copper nickel pipe was fouled with sea growth approximately 50% by volume. The steel sections had no sea growth but oxide and carbonate scale 1/8" thick.

The HCL solutions were 1/2, 3/4 and 1 normal, uninhibited. The ammonium citrate was of 1/2 and double strength. Single strength in this experimental work is defined as 24 lbs. citrate acid and 17 lbs. ammonium hydroxide per 50 gallons water.

The 1 and 3/4 normal hydrochloric acid removed practically all scale and growth and activity in one hour's time. The 1/2 normal hydrochloric acid required 3 hour's time to remove the activity. However, in the case of the copper nickel pipe, considerable marine growth remained at the end of this 3-hour period. The double strength pH solution removed practically all the activity and growth in eight hours' time, whereas the 1/2 strength had removed only 80% of the activity and practically no growth in 16 hours' time.

Figure 1 is a plot of time and hours vs. the activity of the various solutions used in this test. It should be noted that more complete removal was obtained at the end of the first hour in the case of 3/4 and 1 normal hydrochloric acid. This matter is being investigated further.

- (10) USS BARTON - Decontamination of complete fire and flushing system with double strength ammonium citrate - CuNi lines.

This test was set up prior to conclusions being made in the laboratory regarding minimum strength and minimum time of operation. Previous experience on the USS LAFFEY indicated that double strength ammonium citrate at the end of 72 hours standing did not effect complete removal of radioactive matter and effected only 30% removal of sea growth. It was therefore decided to make the USS BARTON test of longer duration, with the exception of two branches of the system which were to be drained at earlier intervals.

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If detriment to this experiment is the fact that the USS BARTON salt water system as a whole contained only small amounts of sea growth, and the fact that few readings on the system were significant enough to record. In an effort to get more significant data 12 valves were dropped before the test so as to obtain inside readings (b + g). Results are summarized.

		<u>Before</u>	<u>After</u>	<u>Hours</u>	
Valve	A	0.002			
	B	0.017	0.009	92	Pipe free.
	C	0.084	0.003	92	Pipe free.
	D	0.002			
	E	0.002			
	F	0.008			
	G	0.072	0.006	92	Few barnacles
	H	0.003			remaining
	I	0.002			
	J	0.001			
	K	0.005			

M. E. TURNBAUGH  
Lieutenant Commander, USN

J. E. HOWELL  
Lieutenant, USN

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UNIVERSITY OF CALIFORNIA

Radiation Laboratory  
Berkeley 4, California

October 3, 1946

SECRET

From: Lt. G. W. Morrison (MC) USN

To: Captain W. E. Walsh (MC) USN  
50 Fell Street  
San Francisco, California.

Subject: Preliminary Studies Concerning Optimum Concentrations of  
Ammonium Citrate Solution Used to Decontaminate Salt Water  
Lines Containing Fission Product Activity.

Ammonium citrate solution was prepared to pH 6 and contained 24 pounds of citric acid and 17 pounds of ammonium hydroxide for every 25 gallons of water. Two more dilute solutions were also prepared, being one-half and one-tenth as concentrated as the above ammonium citrate solution. Sections of radioactive iron pipe four inches long and two and one-half inches in diameter and copper nickel pipe four inches long and four and one-fourth inches in diameter were immersed in separate beakers of citrate solution of the above mentioned concentrations. Samples of the solution were withdrawn at half-hour intervals for the first six hours and then hourly for the next six hours, after the experiment was started in order to determine the rate of removal of fission product activity, as well as the total amount of activity removed by the three solutions from the pipes during the duration of the experiment.

Results:

Iron Pipe: With respect to iron pipe, it was found that 93.6% of the activity was removed by the full strength solution; 91.5% by the one-half strength solution; and 89% by the one-tenth strength solution. Rust

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and scale were removed in all cases except for some scale remaining in the pipe treated with the one-tenth strength solution.

Although the experiment was continued twelve hours, it was found that 70% of the removal of fission products was accomplished in the first three hours except in the case of the one-tenth strength solution. Decontamination of the pipe to the limit of the ability of the solutions was completed within the first ten hours in all cases. It is felt that one-half strength solution is the optimum strength both from the efficiency and economic point of view.

Copper-Nickel Pipe: With respect to the copper-nickel pipe, it was found that 91.5% of the activity was removed by the full strength solution, 73.6% by the half strength solution, and 57.5% by the tenth strength solution. The full strength solution removed all the marine growth from the inside of the pipe; the half strength solution removed about two-thirds of the growth; the tenth strength solution removed only about one-third of the growth.

It was apparent from this series of tests that the removal of about half of the total fission products removable by the solutions was accomplished within the first thirty minutes of the experiment. It is felt that the full strength solution is the most efficient strength for the decontamination of copper-nickel pipe.

Lt. G. W. Morrison (HC) USN

GWM/kt

cc: Capt. Maxwell  
Dr. J. G. Hamilton  
File

SECRET

UNIVERSITY OF CALIFORNIA

Radiation Laboratory  
Berkeley 4, California

October 8, 1946

S E C R E T

From: Kenneth G. Scott

Subject: Point of Action of Decontaminating Solutions

Memorandum to: Admiral T. A. Solberg

AMMONIUM CITRATE SOLUTION

This solution works as a complexing agent. Certain fission products and plutonium in the plus four valence state are attracted by citrate molecules and under optimum conditions form a "complex" or chemical bond. This attraction is great enough to remove plutonium and some of the rare earth fission products from the phosphates, carbonates and hydroxides which also offer absorbing surfaces to these materials when they exist in sea water and are brought in contact with them. Normally, most ships' scales are iron hydroxide (rust) and marine organisms which have calcareous structures which are primarily calcium carbonate and/or phosphate.

Boiler and evaporator scale are also primarily carbonates and sulphates of calcium. What happens then is that the complex formed with fission products and plutonium is greater with the citrate in the decontaminating solution than the attraction offered to the active atoms by the carbonates, hydroxides and phosphates already present. The mass of the total citrate as compared to the total carbonates, phosphates and hydroxides is also a factor since, for example, very low concentrations of citrate would not be able to compete with an enormous quantity of carbonates, phosphates and hydroxides. We do know, however, that one-tenth strength of the original citrate solution used\*

\*Twenty-four pounds of citrate acid, 17 pounds of ammonium hydroxide in 50 gallons of water.

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is sufficient to take the activity and plutonium away from the iron hydroxide found in steel salt water lines.

With respect to the hydrochloric acid solutions, the mode of action is primarily a dissolving action upon the carbonates and phosphates and hydroxides which contain the activity. For example, calcium carbonate plus hydrochloric acid would result in evolution of the carbonate to carbon dioxide gas and the calcium would remain as calcium chloride which is soluble. The acid is used up in this reaction. Calcium phosphate would be dissolved in 1 normal acid and since the active atoms are incorporated with this material which is now in solution, they can be removed by the solution. The hydroxides present are neutralized by the acid and become soluble chloride salts which stay in solution and are removed with the acid plus its dissolved materials. Acid would also be used up in this procedure. Complete neutralization of the acid might cause the active atoms to stick on the surfaces, requiring decontamination, and for this reason sufficiently strong acid solutions have to be used for decontamination. It appears that 1 Normal acid is adequate.

Any washing away or dilution of complexing solutions such as citrate solutions does not offer any serious hazard since the activity would also be washed away at the same time. Your assumptions are correct in that none of the above reactions influence the radiations which are emitted by the fission products and plutonium, but rather allow them to be removed from the scene of operation.

Kenneth G. Scott

KGS/kt

cc: Capt. W. S. Maxwell  
Doctor Joseph G. Hamilton

~~SECRET~~